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ABATEMENT OF THE DUST AND EXHAUST GAS EMISSIONS FROM THE NONFERROUS METAL ORE CONCENTRATE DRYERS

(Ograniczenie emisji pyłów i gazów z suszarni koncentratów
rud metali nieżelaznych)

The problems related to control of emissions discharged from the nonferrous metal concentrate dryers are treated against the background of the concentrate production processes used. The progress made in the control equipment design and its effect on the emission are reviewed and the guidelines for future development are defined.

The roots of the nonferrous metal mining can be traced back to the remote past of the Polish Statehood. The prosperity of this industry suffered also some stagnancy periods, particularly in the prewar times and during the World War II from which it came out seriously crippled.

In the first years after the Liberation lead-zinc ore deposits in the Bytom syncline area and in the Olkusz area came to be redeveloped. In the fifties the flooded copper mines in the Grodziec-Złotoryja region have been put into operation.

The development of national economy and its associate growth in demand for nonferrous metals were the reason for the rapid expansion of the prospecting and geological operations. This work has resulted in the discovery of vast deposits of lead-zinc ores in the Chrzanów-Olkusz and Zawiercie-Siewierz areas as well as copper deposits in the Legnica-Głogów area.

The rapid growth in the ore mining industry in the postwar period was accompanied by changes in the mining techniques and by work mechanization. Parallel with the development of mining industry the environment pollution control problems became growing in importance, including the problems of the discharge of dust and gaseous emissions into the atmospheric air.

The question of dust and gas emission is of high importance in view

of the notable economic impact in the form of an adverse effect upon the environment (especially SO_2) and the irreversible loss of metals, thus a decreased recovery of the metals from ores processed.

The Nonferrous Metal Ore Dressing

Copper Ores

The Lower-Silesian copper ore deposits are connected with the following three lithological strata, viz., sandstone, schistic and calcareous layers. The ore is monometallic in character. The basic useful metal is copper. The majority of copper minerals there are copper sulfides, of which ranking first is chalcosine; the remaining copper is in the form of bornite and chalcopyrite.

Copper ores are dressed by flotation. The process used employs crushing and pregrinding inclusive of classification and interstage grinding in a closed cycle. The flotation process is run in two stages with developed systems of concentrate cleaning with interstage grinding of intermediate products.

Lead-Zinc Ores

The major minerals of the sulfide lead-zinc ores are sphalerite, galena, and marcasite. Beside the sulfide minerals in these ores there appear oxide minerals as smithsonite and cerussite. The gangue is made up of dolomites.

Two-stage closed systems are used for ore crushing. For the preliminary concentration of sulfide lead-zinc ores, heavy liquid suspension scrubbers are in use. In the pre-concentration process dolomite is isolated, and the intermediate product is delivered for the flotation process. The flotation process proceeds selectively with isolation of zinc and lead concentrates, and flotation tailings.

Preparation of the Concentrates for Metallurgical Process

The nonferrous metal concentrates obtained from flotation are delivered via mechanical thickeners for water draining to cylinder- or disk-type vacuum filters. The moisture content in the concentrate after these operations is 20-28% for copper concentrate and 10-15% for lead-zinc concentrate. The concentrates upon filtration are dried in the dryers.

Concentrate Drying Processes

Metallurgical processes often require a fairly deep drying (even down to 6%). From the environment pollution control standpoint both the degree of drying, dryer design, and the kind of fuel used are rather essential, as these factors affect the air pollution level with solid and gaseous (SO_2) emissions. Cylinder dryers (smooth cylinders) of a capacity ranging from 5 to 8 tons/hr are used for drying of zinc and copper ore concentrates. The dryers are coal- or gas-fueled. The coal for dryer firing contains sulfur up to 1%.

Properties of Gases and Dusts Generated in the Concentrate Drying Process

Depending upon the dryer capacity the quantity of exhaust gases ranging from 15 thou to 25 thou m^3/hr (STP). The gas temperature at the dryer outlet amounts to 105–135°C. The average chemical composition of gas is as follows:

- oxygen — 17.8%,
- nitrogen — 79%,
- carbon dioxide — 3%,
- carbon monoxide — 0.2%,
- absolute moisture content of gas — 50–100 kg water/kg of dry gas.

For coal-fired dryers the exhaust gases contain about 0.2 g/m^3 (STP) of SO_2 , whereas from natural gas-fired dryers sulfur dioxide occurs in traces.

The dust concentration values in exhaust gases range from 5 to 10 g/m^3 (STP) and depend upon the degree of dryness of the concentrate which varies in the range 7–9%. Physicochemical properties of dusts from the ore concentrate dryers are shown in Table 1.

Table 1
Physicochemical Properties of Dusts from the Ore Concentrate Dryers

Property	Unit	Dust from dryers	
		Cu	Zn
Specific gravity	g/cm^3	3.35	4.80
Packed bulk density of dust	g/cm^3	0.915	1.50
Angle of repose	deg.	38	40
Particle size distribution			
0–5 μm	%	10.0	1.0
5–10 μm	%	12.0	1.3
10–20 μm	%	20.0	15.0
20–40 μm	%	35.0	58.5
20–60 μm	%	18.0	19.5
> 60 μm	%	5.0	4.5

The Emission Control Devices and Their Performance

Copper Mining

For the emission control of the copper concentrate dryers single- or double-stage systems are widely used. In the single-stage systems gases are treated exclusively in wet scrubbers. Double-stage systems consist of a cyclone battery and impingement scrubbers set up as the last in the train. The first impingement scrubber designs ensured the final dust concentration of 1-2 g/m³ (STP). The improvement in the scrubber design resulted in a gradual drop in the dust emission into the atmospheric air. The performance data for the control units and systems employed are collected in Table 2.

Table 2
Performance Data for the Emission Control Devices Used in the Copper Concentrate Dryers

Device type	Dust concentration g/m ³ (STP)	Dust emission rate kg/hr	SO ₂ concentration g/m ³ (STP)	SO ₂ emission rate kg/hr
Impingement scrubber	1.0-2.0	35.0	0.15	10.0
Cyclone collector-impingement scrubber system	0.15-0.5	3.0-10.0	0.10	6.6
Impingement scrubber of improved design	0.10-0.15	2.0- 3.0	0.10	6.6

Today in new copper mining plants the emission control systems in use incorporate a bank of cyclones and an impingement scrubber. The bank of cyclones consists of six single cyclone collectors of internal diameter of 750 mm, arranged in two rows. The dust-laden gas is fed tangentially through inlet tubes to individual cyclone collectors, wherefrom, upon preliminary cleaning, it is led on through an outlet tube to an impingement scrubber. The impingement scrubber belongs to the wet inertial separators group. The essential part of the device is the impingement chamber partly filled with water. The dust-contaminated gas stream impinges upon the water surface in the chamber with a high velocity, thereby producing a highly developed contact surface of a high turbulence. As a result, dust particles become precipitated. Subsequently, the gas passes through a series of baffles of a demister chamber and, deprived of water droplets, it leaves the device. The impingement scrubber is provided with an external water circulation system. Dirty water is fed to settling tanks, wherefrom clear water is recycled. The use of the flotation department facilities for the purpose eliminates the major drawback of

this dust control devices which is a troublesome water and sludge management. An additional advantage of the wet collection devices for the control of dryer exhausts is that sulfur dioxide is also washed out from the gas stream. The sulfur dioxide absorption is estimated at 60%.

Performance data on the cyclone battery-impingement scrubber assembly are the following:

- capacity — 25 thou m^3/hr ,
- dust concentration upstream of the collection unit — 10–15 g/m^3 (STP),
- final dust concentration — 0.15–0.20 g/m^3 (STP),
- collection efficiency — 99–99.5%,
- hydraulic resistance for the battery — 80 kg/m^3 ,
- hydraulic resistance for the scrubber — 240 kg/m^3 ,
- water requirements — 20–50 m^3/hr .

Operation of the cyclone battery-impingement scrubber system is featured by a fairly high unreliability. The failures are due to nozzle fouling, sludge disposal problems, clogging of demisters, as well as to accelerated erosive and corrosive processes of individual structural parts of the unit.

The impingement scrubbers used are gradually supplanted by their improved version, equipped with an additional cyclone demister. The scrubbers of the new design will be featured by a considerable reliability in view of the following measures taken:

- gas feed nozzle and the tank bottom are constantly washed,
- water table in the scrubber can be adjusted (nozzles can move up and down),
- rectangular nozzle over the entire scrubber width,
- baffles that partly remove mist from gas right in the scrubber.

The final demisting will take place in a cyclone demister. Dust concentration downstream of the scrubber at the hydraulic resistance of the scrubber itself of an order of 150–200 kg/m^3 will range from 0.1 to 0.15 g/m^3 (STP). Moreover, sulfur dioxide will be washed out with an efficiency of about 70%.

Currently the copper concentrate dryers discharge into the atmosphere 1400 tons/year of dusts and 1000 tons/year of SO_2 .

In addition to the constant improving of the design of dust collection devices, the main trend in the efforts to reduce particulate and gaseous emissions is the use of natural gas as fuel and the raising of stacks to a height that would ensure an optimum dispersal of emissions.

Lead-Zinc Mining

For the dust collection from the zinc concentrate dryer exhausts fabric filters, high-performance scrubbers, and impingement scrubbers coupled with cyclone collectors were commonly used. The performance characteristics of the emission control equipment employed are given in Table 3.

Table 3
Performance Data for the Emission Control Devices Used in the Lead-Zinc Concentrate Dryers

Device type	Dust concentration g/m ³ (STP)	Dust emission rate kg/hr	SO ₂ concentration g/m ³ (STP)	SO ₂ emission rate kg/hr
Filterbags	3.1	45.0	0.2	2.5
High-performance scrubber	0.15-0.45	2.0-7.0	0.1	1.2
Impingement scrubber coupled with a cyclone demister	0.15	1.5	0.05	0.63

Fabric filters (filterbags) were fitted to the first zinc concentrate dryers to have been built after the War. The filters featured a filtration area of about 150 m². The filter fabric of the bags was cotton, and later Elana[®]. The fabric was cleaned by rapping and by air reversals. Because of a considerable moisture content in the exhaust gases, the bags used to clog from the water condensed there. The dust accumulated used to produce a slime layer hard to remove, which entailed increased filtration resistance and impeded all the waste gases to be exhausted from the dryer.

The filterbags were subsequently superseded by high-performance scrubbers. Their operation, however, was also difficult on account of nozzle and demister fouling. Finally, as a result of constant improving of the design, an impingement scrubber has been developed to replace today all the older control equipment of the zinc concentrate dryers. The impingement scrubber in point incorporates a dust collection section which accommodates three gas nozzles and a cyclone demister. The nozzles are provided with scrapers to dislodge slime deposits. The scrapers are manually operated. The dust-laden gas is delivered through a header to the nozzles. The gas stream that comes out at a high speed impinges upon water surface with the resultant arresting of dust particles. After cleaning the gas flows into the cyclone demister and on outside. The spent water is directed to a settling tank through discharge tubes

and an overflow. The cleared water from the tank is recycled back to the scrubber.

Performance characteristics of the impingement scrubber:

- gas temperature at the scrubber inlet — 60–180°C,
- gas temperature at the scrubber outlet — 30–70°C,
- gas flow rate — 12,000–18,000 m³/hr,
- dust concentration, inlet — 0.7–10.0 g/m³ (STP),
- final dust concentration — 0.1–0.15 g/m³ (STP),
- hydraulic resistance — 180–250 kg/m².

Currently the zinc concentrate dryers release into the atmosphere about 180 tons/year dust and about 100 tons/year SO₂.

The major factor in the reduction of dust concentration in the exhaust gases from the zinc concentrate dryers has been the development of a process which consists in a direct feeding of the flotation pulp to the metallurgical departments. The pulp there is subjected to suitable improving operations which are free of dust and gas emission, and subsequently it is sent to metallurgical processes.

Conclusions

To sum up the experience gained so far it has to be said that the abatement of particulate and gaseous emissions from the nonferrous metal concentrate dryers can be achieved not only by modernization of the existing emission control devices, expansion of the systems and improving of their design but also, and to a considerable extent, by the change in the fuels used and in the drying, and concentrate processing techniques employed. Considering the difficulties with the availability of low-sulfur coal grades, and the fact that not everywhere gasification is possible, implementation of new design final emission control stages will be continued.

A device of great promise seems to be washed-confusor low-pressure Venturi tubes. Assumingly the dust concentration downstream of the tube will not exceed 50 mg/m³ (STP), and the SO₂ trapping efficiency will reach 80 to 85%.

The fact that nonferrous metallurgical industry has definite long-range plans related to the implementation of new design and novel processes is a guarantee for a substantial limitation of the deleterious effect of the dryers upon the natural environment in the vicinity of mining plants.

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THE AEROSOL CONCENTRATION IN THE AIR OF THE AREAS OF VARIOUS TRAFFIC INTENSITY IN THE CITY OF ŁÓDŹ

(Stężenie aerozoli w powietrzu rejonów o różnym nasileniu ruchu pojazdów mechanicznych w m. Łodzi)

Total aerosol, tarry matter, and benzo[a]pyrene concentrations were monitored in three measurement stations featured, among other things, by different traffic intensity. At the current motor vehicle traffic rate the emission concentrations nearly attain the threshold limit values.

Deleterious properties of chemical compounds absorbed by humans in high concentrations are generally well recognized. However, a simultaneous effect of a number of chemicals present in the environment of man in low concentrations has not as yet been sufficiently learnt and needs a constant observation, as this may appear after a longer time. Increased number of emission sources in our environment imposes the necessity of air pollution monitoring. The liquid-fuel combustion-derived toxic compounds are measured only occasionally in this country, in general in large cities [1]-[8].

For the area of the city of Łódź data are available for lead [5] and polycyclic aromatic hydrocarbons (PAH).

The aim of this study was to investigate the correlation between concentration of some of the air pollutants and vehicular traffic. Results obtained are related to solid particulates and benzo[a]pyrene (BaP).

Method of Measurements

Air samples were collected at three sites in the city. The investigation was carried out in 1975 and 1976. Station 1 was situated downtown by one of the busiest street, at the intersection of two streets, 20 and 7 m

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wide, without greens and built up with three- and four-story buildings. Station 2 was located some 35 m from a 10-m wide street and was surrounded with greens and vegetation. Both stations are situated in the districts of the city where the majority of buildings are not connected to the heating network system of the thermal power station. Station 3 was set up in a large park some 350 m from the street.

The mean 24-hr air samples were taken within 24 hr, instantaneous samples within 2 hr in the daytime between 9:00 and 3:00 and in the night between 1:00 and 3:00. Suspended aerosol and tarry matter were determined gravimetrically [9]. Benzo[a]pyrene (BaP) was analyzed spectrofluorimetrically upon the separation of polycyclic aromatic hydrocarbons (PAH) by two-dimensional thin-layer chromatography [10]. Detectability of these substances by the methods used is reported in Table 1.

Table 1
Detectability of the Substances Analyzed
by the Analytical Methods Employed

Pollutant	Detectability $\mu\text{g}/\text{m}^3$
Suspended aerosol	100
Tarry matter	10
Benzo[a]pyrene	0.03

To collect enough data required for characterization of the traffic intensity, the number of cars and motorcycles was repeatedly recorded during the sampling. At station 1 was also noted the number of brakings at the stop light there, which is equivalent to the number of starts upon changing of the lights. In the sampling days weather conditions were recorded, such as temperature, wind speed, and type of weather.

Results of Measurements

Traffic Intensity

Traffic intensity at measuring stations 1 and 2 is illustrated in Table 2. The average number of vehicles passing at station 1 in the daytime between 9:00 and 3:00 is 1227 and at night, 124. At station 2 the traffic intensity is one fourth of the former value, the average number of vehicles in the daytime hours being 310.

Aerosol Concentration

The mean 24-hr aerosol concentration found at stations 1 and 2 is shown in Table 3. Mean concentration of suspended dust is 211 and 163 $\mu\text{g}/\text{m}^3$, tarry matter 24 and 20 $\mu\text{g}/\text{m}^3$, and benzo[a]pyrene 55 and

Table 2
The Average Number of Vehicles Passing by the Measuring Station during One Hour

Observation		Number of vehicles					Braking
month	hours	total	with diesel engine	with 4-stroke engine	with 2-stroke engine	motorcycles and motor bicycles	
Station 1 May-August December December	9:00 a.m.-3:00 p.m.	1150	216	694	144	96	732
	12:00-2:00 p.m.	1304	212	786	302	4	618
	1:00 a.m.-3:00 a.m.	124	34	87	3	—	45
Station 2 March	10:00 a.m.-1:00 p.m.	310	48	292	18	—	7

Table 3

The Mean 24-hr Concentrations of Aerosols

Sampling station	Month	No. measurement	Concentration					
			dust $\mu\text{g}/\text{m}^3$		tarry matter $\mu\text{g}/\text{m}^3$		benzo[a]pyrene ng/m^3	
			range	arithmetic means	range	arithmetic means	range	arithmetic means
1	1975							
	April	6	150-457	236	22-36	26	23-51	34
	May	5	156-189	173	14-25	18	24-72	38
	June	5	179-307	213	19-34	27	24-50	34
	December	8	139-352	237	9-20	14	54-133	68
	1976							
2	1975							
	April	8	94-302	189	9-28	15	8-97	31
	May	12	150-314	218	12-48	24	4-41	15
	June	11	61-208	120	12-20	16	4-14	10
	July	12	74-194	124	7-16	11	2-8	4
	Total period	43	74-314	163	7-48	20	2-41	11

Table 4
The Instantaneous Aerosol Concentrations

Sampling station	Time of day	Month	No. measurements	Dust $\mu\text{g}/\text{m}^3$		Tarry matter $\mu\text{g}/\text{m}^3$		Benzo[a]pyrene ng/m^3	
				range	arithmetic means	range	arithmetic means	range	arithmetic means
1	day	May	16	105-536	332	36-92	63	34-122	58
		December	10	160-884	444	79-164	114	87-437	194
		January	8	108-275	212	86-120	107	177-565	310
		total period	34	105-884	329	36-164	94	34-565	157
1	night	December	7	62-173	121	55-94	69	49-68	58
3	day	January	2	25-35	30	16-25	20	47-46	46

11 $\mu\text{g}/\text{m}^3$, respectively. The instantaneous aerosol concentration in the daytime was measured at stations 1 and 3 whereas at station 1 also at night (Table 4).

At station 1 in the daytime, dust concentration ranges from 105 to 884 $\mu\text{g}/\text{m}^3$ (average 329 $\mu\text{g}/\text{m}^3$), tarry matter from 36 to 164 $\mu\text{g}/\text{m}^3$ (average 94 $\mu\text{g}/\text{m}^3$), benzo[a]pyrene from 34 to 565 ng/m^3 (average 157 ng/m^3). At the same site the respective nighttime concentrations are: dust, 62–173 $\mu\text{g}/\text{m}^3$ (average 121 $\mu\text{g}/\text{m}^3$); tarry matter, 55–94 $\mu\text{g}/\text{m}^3$ (average 69 $\mu\text{g}/\text{m}^3$); benzo[a]pyrene, 49–68 ng/m^3 (average 58 ng/m^3).

At station 3 in the daytime, the mean daily concentration for dust is 30 $\mu\text{g}/\text{m}^3$, tarry matter, 20 $\mu\text{g}/\text{m}^3$, and benzo[a]pyrene, 46 ng/m^3 .

Criteria for Evaluation of the Results

For evaluation of the concentration of the atmospheric emissions measured, the threshold limit values according to the Order of the Council of Ministers of September 13, 1966 [11] were assumed along with the recommended threshold limit value list [12]. The respective values are collected in Table 5.

Table 5
The Threshold Limit Values

Substance	Concentration $\mu\text{g}/\text{m}^3$	
	instantaneous	24-hr
Dust	600	200
Tarry matter	120	50
Benzo[a]pyrene	0.05	—

Discussion of Results

The results shown indicate that the measuring stations differ significantly from one another by the distance from the traffic route, the landscaping (greens or their lack), and traffic intensity. The house heating manner for stations 1 and 2 is similar. Values of the 24-hr concentrations of the emissions examined over the entire period of the measurement at stations 1 and 2 are presented as the logarithmic-normal distribution function in Figs. 1 and 2. Geometric means of the dust concentration at measuring stations 1 and 2 are 200 and 140 $\mu\text{g}/\text{m}^3$ and for benzo[a]pyrene, 45 and 8 ng/m^3 , respectively. These values differ statistically significantly among themselves. Dust concentrations at station 1 range at the level of

the threshold limit value of $200 \mu\text{g}/\text{m}^3$. For the 24-hr concentration of benzo[a]pyrene the threshold limit value has not as yet been established.

The number of results exceeding the threshold limit values is for dust: 50% at station 1 and 25% at station 2. The tarry matter level at both stations is alike and ranges within the threshold limit value. For an exact determination of the effect of vehicular traffic on atmospheric pol-

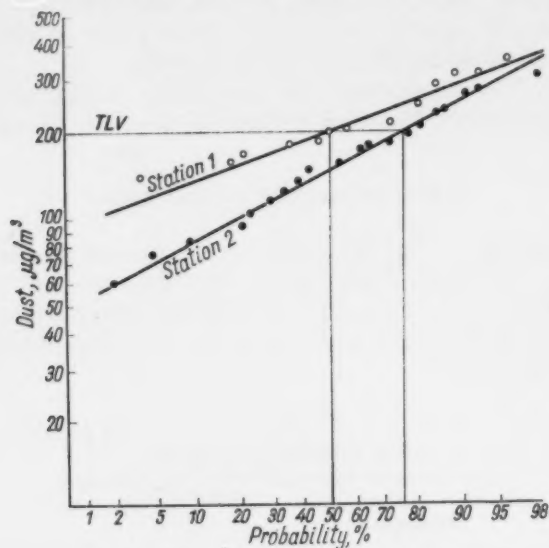


Fig. 1. The log-normal distribution function for the mean 24-hr concentration of solid particulates at measuring stations 1 and 2.

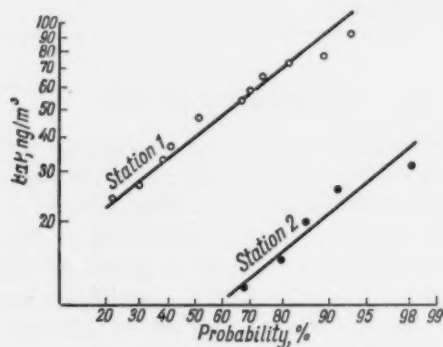


Fig. 2. The log-normal distribution function for the mean 24-hr concentration of benzo[a]pyrene at stations 1 and 2.

lution, the continuous recording of both the parameters over the entire 24-hr period appears desirable. For independent reasons the authoresses had to restrict their study to the analysis of 2-hr concentrations in the daytime and night hours at station 1.

Concentrations of the substances studied at station 3 (Table 4) illustrate to some extent the background characteristic of the urban area which is due to the direct emission source. The corresponding results from December (Table 4) indicate a rise in the average concentration for dust from 121 $\mu\text{g}/\text{m}^3$ at night to 444 $\mu\text{g}/\text{m}^3$ in the daytime, for tarry matter from 69 to 114 $\mu\text{g}/\text{m}^3$, and for BaP from 58 to 194 ng/m^3 , respectively.

Emission concentration at night at station 1 are three- and fourfold higher than those at station 3 in the daytime hours. Only the BaP concentration in the daytime hours at station 3 and in the night hours at station 1 is much alike, a possible indication of a relatively high stability of aerosol of this compound. All the instantaneous concentration values at station 1 from the entire 24-hr period are shown as a log-normal distribution function in Fig. 3. Geometric means of dust concentration, tarry matter, and BaP are 210 $\mu\text{g}/\text{m}^3$, 75 $\mu\text{g}/\text{m}^3$, and 73 ng/m^3 , respectively. All the means are lower than the threshold limit values. The number of

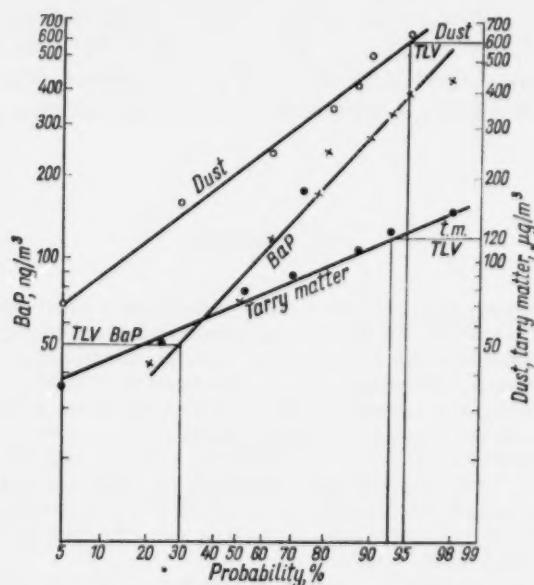


Fig. 3. The log-normal distribution function for the instantaneous concentrations for dust, tarry matter, and benzo[a]pyrene at measuring station 1.

results exceeding the threshold limit value is, for dust 50%, tarry matter 70%, BaP 70%. No relationship between weather conditions and the atmospheric pollution level could be demonstrated possibly because of the limited number of the analyses made. None of the analyses performed was sampled under weather conditions favorable for smog formation.

The concentrations of the emissions examined measured in the Łódź downtown area are higher than the values determined earlier in other cities of this country [1], [4], [6].

The finding of this investigation that motor exhausts are a serious air pollution source merely supports the consensus on this question. However, the concentration levels determined for solid particulates and benzo[a]pyrene under conditions of the area under investigation alert serious problem of sanitary character. Even today the emission concentrations are considerable. In the aspect of constant development of motor vehicle, emission level will rise unless adequate engineering measures are undertaken. Obviously the enhanced pollution level would impair health conditions of population of the city, especially under unfavorable weather conditions. Noteworthy is also the recognized fact that, in addition to the emission species studied here, there is a vast number of other toxic compounds in the atmospheric air. In this investigation beside benzo[a]pyrene four other polycyclic aromatic hydrocarbons were detected in tarry matter by thin-layer chromatography. Of these hydrocarbons merely perylene exhibits no carcinogenic properties. The carcinogenic PCAHs include benzo[g,h,i]perylene, benzo[k]fluoranthene, and benzo[e]pyrene.

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A COMPARATIVE STUDY ON THE GAS BURNERS FOR WASTE GAS THERMAL AFTERBURNING

(Badania porównawcze palników gazowych przeznaczonych do termicznego
dopalania gazów odpadowych)

Efficiency of the treatment of low-heat value industrial waste gases by thermal afterburning technique depends upon the burner and combustion chamber designs. Results of a study on the gas burner designs suited for the treatment of waste gases are given along with a discussion of these designs.

Tail gases of low-heat value are the waste in a great number of manufacturing processes. Generally the gases consist of some combustible components inclusive of carbon monoxide, hydrogen, light hydrocarbons, and heavy hydrocarbons in minor amounts, and considerable quantity of nonflammables. Although not infrequently these gases exhibit a toxic activity they are vented to the atmosphere in the final stage of the manufacturing process with the resultant contamination of the environment [1]-[3]. Quite often the heat carried along with these gases is not recovered, which entails some economic losses.

The pollution control in the case of flammable industrial effluents that constitute a nuisance to the environment by mechanical, biological, or chemical routes is often inefficient, frequently fairly expensive or even impracticable at all. In this connection more attention is being paid recently to possible ways of the disposal of these wastes by catalytic and thermal afterburning techniques [4]-[5]. As distinct from the catalytic method, the thermal afterburning process is insensitive to catalyst poisons and to the presence of condensed admixtures (e.g., dusts, mists, etc.).

A properly run combustion process provides such a concentration level of contaminants in the exhausts that is virtually unarmful to the biosphere and permits of the heat recovery from tail gases. Because tail gases commonly represent a complex multicomponent mixture of a con-

siderable variability in their composition with time, an unambiguous determination of conditions of their combustion process is impossible. Most of tail gases feature narrow limits of inflammability, low normal combustion rate, and little heat value. For that reason the problems related to intensification of the combustion process and the provision of stationary burning conditions prove to be complex and are feasible after investigation and analysis of the following factors: physicochemical properties of tail gases, combustion chamber design, and burner design features [6]–[7]. From the vast body of problems of utilization and disposal of tail gases by the thermal afterburning process the following two points should be distinguished. The first is an answer to the question until what concentration of inert components in the fuel a stationary flame can be maintained in a specific equipment; the second is at what critical flow rate of combustible mixture the flame will break up for a given gas and specific conditions of the burning process in that equipment. Solution of these problems is essential for high efficiency and safety of the process.

There are a number of designs of combustion chambers and burners used for the tail gas disposal. It follows from a review of patent designs of the burners that these devices have many common design features [3]. These are largely concerned with two questions: the way combustible mixture is prepared, and the way a stationary flame is accomplished. A trend may be observed in the use of such ways of the mixture preparation which would ensure independence of the final composition of the mixture upon the initial tail gas flow rate and the initial oxidant flow rate. Owing to this, the range of fuel-to-oxidant ratio would always fall above the lower limit of flammability. To ensure stationary combustion the following flame stabilization measures are common: by means of the wall layer, by providing energy from the outside, and by thermal and aerodynamic recirculation.

Considering all the above observations, investigations are under way to develop gas burners designed for afterburning of tail gases of low-heat value. The investigations are conducted at Institute of Thermal Technics and Fluid Mechanics of Technical University of Wrocław to the order of PROAT Atmosphere Conservation Designing Office in Szczecin. Based on laboratory results gas burner designs have been advanced which, in the authors' opinion, feature good properties of flame stabilization.

Method and Results

In the study the diffusive flame combustion was assumed in view of the following: stabilizing and self-stabilizing properties of this kind of flame, simplified investigation technique, and a possibility to generalize

the results obtained also over the kinetic flame. In order to compare the stabilizing properties of the gas burners examined, standard characteristics of the diffusive flame stability characteristics were measured (Figs. 1 and 2) for a simple burner composed of two concentric nozzles through which flow a model gas, methane diluted with nitrogen (inside nozzle), and air (outside nozzle). This burner is henceforward referred to as the model diffusive burner. Since the diffusive flame, just like the kinetic flame, becomes unstationary once a specific fuel or oxidant flow rate is exceeded (the flame comes off the nozzle to break completely, or it persists as

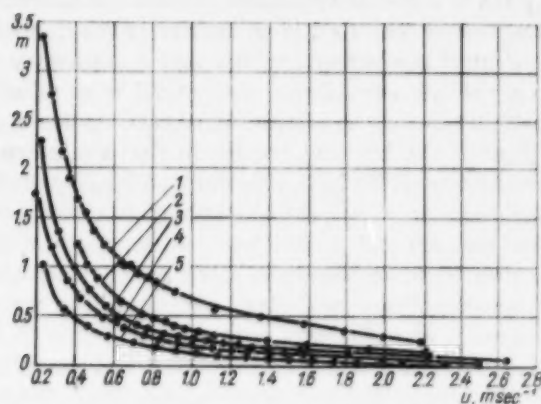


Fig. 1. Methane flame rise rate vs. m parameter at various nitrogen concentration C_{N_2} in the fuel: 1 — 0.05; 2 — 0.24; 3 — 0.43; 4 — 0.52; 5 — 0.62.

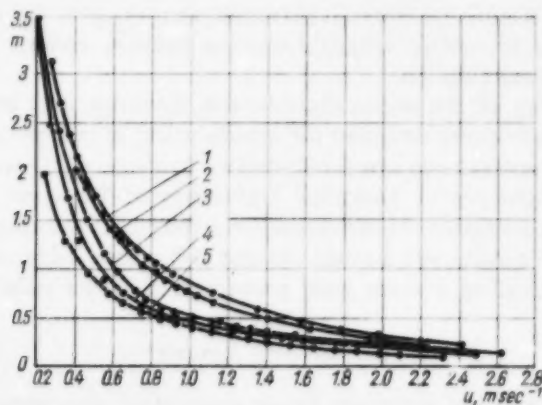


Fig. 2. Methane flame break rate vs. m parameter at various nitrogen concentration C_{N_2} in the fuel: 1 — 0.05; 2 — 0.24; 3 — 0.43; 4 — 0.52; 5 — 0.62.

a turbulent risen flame that breaks up with more increased flow rate), the flow rate corresponding to the flame rise or break was taken as a quantity characteristic of flame stability. The flame rise or break was determined in the following way. At a fixed flow rate of methane, air, and nitrogen the flame was being watched for about 5 min. If the flame stayed unrisen or unbroken, the flow rate of one of three gases mentioned was increased until a new flow rate was established. Based on the results obtained, flame break curves were plotted for all of the burners examined, i.e., the model diffusive burner, gauze burner, pilot flame burner, and ionization burner. The experimental setup is described elsewhere [8].

The character of the rise and break curves for the diffusive flame in the model burner is similar (Figs. 1 and 2). The differences in the rate values at which the flame rises or breaks are slight and decrease with the value of m parameter at a constant nitrogen concentration in the mixture. This means that the combustion process intensification range is little for $m > 1$, and it may be assumed that the burner performance in terms of flame stability is determined by the flame break speed. Collective characteristics of flame stability for the burners studied in the form of flame break curves at various nitrogen concentration in the mixture are illustrated in Figs. 3 and 4. It was found on the basis of the study made that the best performance provides the pilot burner. The energy delivered in the pilot flame is not higher than 10% of energy of

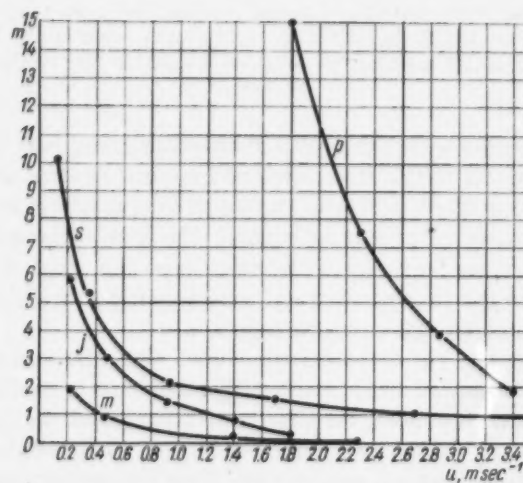


Fig. 3. Comparative characteristics of burner stability for burners of various design for $C_{N_2} = 0.60$: p —pilot burner; s —gauze burner (4×10^4 mesh/ m^{-2}); j —ionization burner (10 V, 1310 rpm $^{-1}$); m —model burner.

the master burner. Pilot flame serves as a constant lightup source. It also raises the process temperature, which markedly improves flame stability. Waste gas flame stabilization by means of a pilot flame is an infrequent practice [9] largely on account of increased operating costs of the equipment. However, heat recovery was not considered there as an economy-improving measure. The suppressed-flame burner (gauze) provides worse flame stabilization properties than the pilot flame burner. Operation of

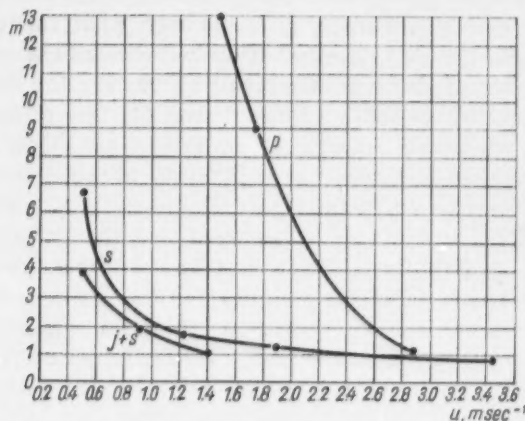


Fig. 4. Comparative characteristics of burner stability for burners of various design for $C_{N_2} = 0.80$: m —model burner fails to burn; j —ionization burner (12 V, 1310 rpm⁻¹, gauze 4×10^6 mesh/m⁻²); s —gauze burner (9×10^6 mesh/m⁻²); p —pilot burner.

the burner equipped with gauze as a flow-suppressing part resolves itself into the lowering of initial flow rates of fuel and oxidant streams at the place where flame front develops. Owing to this, waste gases featured by low normal burning rates can be burned. The stable operation range for the ionization burner increases with the voltage and spark frequency. The spark causes the gas to dissociate and ionize owing to which ignition conditions of combustible gas mixture improve.

Analysis of the results obtained shows that the manner in which the constant ignition of fresh combustible mixture is maintained at the burner nozzle exit is critical for the flame stability of the low-heat value combustible gases. To achieve these conditions, to facilitate self-ignition of the combustible mixture, swirlers and flow suppressors are used in the waste gas afterburners to suppress flow at the fuel and oxidant contact surface. Most commonly, however, because of low-heat value of such gases these methods are not fully efficient. In this connection the

burning process should be so set up as to force ignition of the fresh mixture. Among these measures are exhaust recirculation chambers, pilot flames, or electric spark ignition.

A number of interesting conclusions may be drawn from the study performed in relation to the tail gas afterburning process. These are:

- Tail gases of heat value $< 2000 \text{ kJ/m}^3$ (STP) can be burned under stationary conditions at rates below 10 m/sec; the recommended initial rate should be as low as possible (for the risk of flame break).

- In the combustion of tail gases at the moment the flame moves off the burner nozzle the flame breaks. It should not be expected that the flame would burn on as a risen flame unless it is stabilized by hot combustion chamber walls.

- If additional fuel has to be delivered to ensure correct process of tail gas afterburning, that additional fuel should be fed as a pilot flame rather than in mixture with tail gases. This will permit continuation of the process despite considerable variations in composition of tail gas.

Design of the Tail Gas Thermal Afterburning Burners

Basic features of the burner design depend upon the afterburning process employed. Fuel and oxidant may come out of the burner as separate streams or as a single stream of mixed fuel and oxidant. For these two manners of fuel and oxidant feeding respective names for burners (and flames) are in use, namely, the diffusive and kinetic one. The diffusive flame is safer as concerns stability than kinetic flame. Its application, however, is limited on account of the hitherto employed methods of the reduction of concentration of pollutants in the exhausts. The point is that tail gases are not infrequently diluted with air, which practice, from the standpoint of the thermal afterburning process, is highly economically unsound. This is because increased additional fuel is required along with extensive heat recovery system. The diffusive flame compared with the kinetic one may be featured by enhanced emission of high-temperature oxidation products and intermediates on account of poor mixing of the fuel with oxidant. In authors' opinion, however, diffusive flame provides a much more uniform temperature distribution in the combustion chamber along its entire length, reducing thereby incomplete combustion arising from poor mixing in that flame.

Presented below are burner designs of the pilot flame and gauze types developed on the grounds of own studies and literature search. The burners are typical diffusive designs. After a minor modification they can, however, be employed as kinetic burners. The remaining types discussed here are of a mixed kinetic-diffusive types.

The Pilot Flame Diffusive Burner

Of the most simple design is the pilot flame diffusive burner (Fig. 5) constructed of four coaxial steel tubes. The fuel, additional fuel, and oxidant feeding is shown in the figure. Flame stabilization is ensured by the high-heat value gas flame (e.g., hydrogen or methane) produced at the burner exit. The burner may be of the slit or turbulent design.

The Gauze-Type Diffusive Burner

Figure 6 illustrates the design principle of the diffusive burner with a flow-suppressing insert. The essential modifications of this burner type that make it different from a simple diffusive burner are: the manner of feeding the tail gas and oxidant and the high-heat value fuel, a provision of a flow suppression part at the burner nozzle exit, and the exhaust recirculation chamber housing the nozzle exit. Tail gas and oxidant are fed tangentially to the respective ports, whereas the high-heat value gas is introduced axially. The suppressor in the form of a suitable mesh gauze is designed to change the distribution of the oxidant and tail gas flow rates at the burner exit, with the resultant improvement in flame stability. The housing of the burner exit in a firebrick-clad chamber makes the exhausts recirculate, which favors burner performance as to flame stability.

The Cone-Stabilizer Mixing Chamber Burner

The major difference between the gauze burner and the cone stabilizer burner is in the nozzle design (Fig. 7). In the cone stabilizer type the innermost axial tube which is feeding the high-heat value fuel is ended with a cone. A number of openings are provided in the cone through which the gas of high-heat value is streaming out to the burner nozzle. The openings stabilize the tail gas burning process. The cone position may be adjusted according to the combustion process conditions required. Another novelty is the mixing chamber that houses the tail gas tube exit. At the mixing chamber exit a pilot flame is produced which improves the burner's stabilizing property. Like in the gauze type the burner nozzle exit is housed with a recirculation chamber. The feature of the cone stabilizer burner is that, depending upon the tail gas combustion process, all the flame stabilization measures described can be applied independently or in diverse combinations.

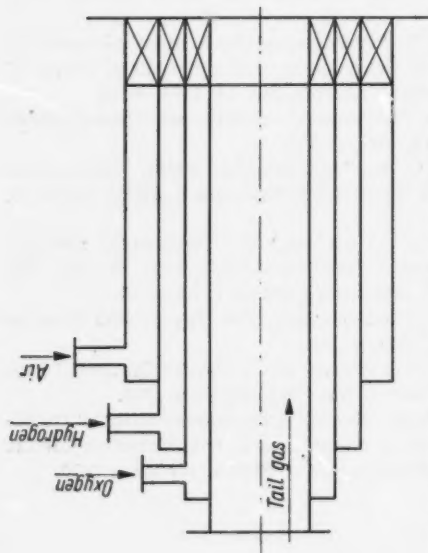


Fig. 5. Diagram of the pilot flame diffusive burner.

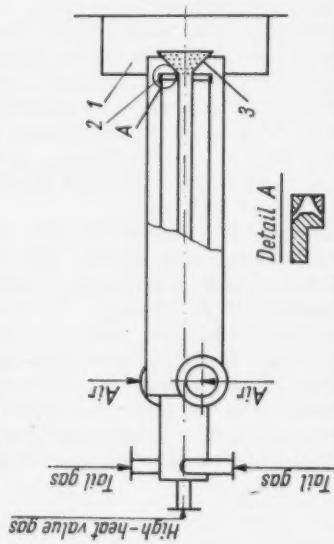


Fig. 7. Diagram of the cone-stabilizer mixing-chamber burner: 1 — recirculation chamber; 2 — mixing chamber; 3 — cone.

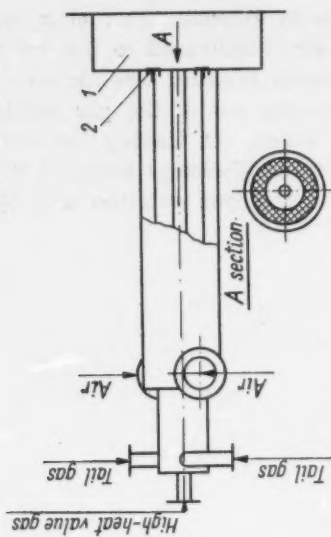


Fig. 6. Diagram of the gauze diffusive burner: 1 — recirculation chamber; 2 — gauze.

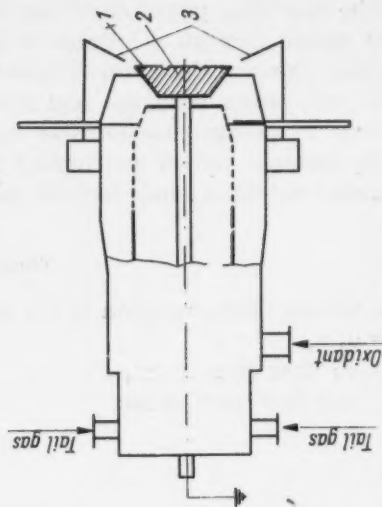


Fig. 8. Diagram of the ionization burner: 1 — ground electrode; 2 — cone stabilizer; 3 — electrodes.

The Ionization Gas Burner

The operating principle of the burner is as follows. The fuel is fed to the nozzle through a suitable tube, and air is delivered to the space contained between the gas nozzle and the burner housing. The air mixes in the exit nozzle with the fuel streams coming out of the gas nozzle openings to produce combustible mixture which, on leaving the exit nozzle, becomes ionized and ignited by electrical discharge between the electrodes and the ground electrode mounted on the cone stabilizer (Fig. 8).

Notation

- C_{N_2} — nitrogen concentration in the fuel,
 $m = u_1/u$,
 u_1 — air flow rate, m/sec,
 u — fuel flow rate, m/sec.

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METALS IN THE DUST OF URBAN ATMOSPHERE ON THE EXAMPLE OF THE CITY OF WARSAW

(Metale w pyłach atmosfery miejskiej — na przykładzie m.st. Warszawy)

Toxicology of some metals and concentration distribution of chromium, copper, lead, manganese and iron in the fallout dust in Warsaw are discussed along with possible method for determination of trace metals in suspended particulates by the atomic absorption spectrophotometry.

In the light of recent scientific achievements micronutrient elements which include also metals contained in water, soil and food are of great significance for the health of man.

Attention was called to the fact of increased metal concentration in the air, especially in cities, in the studies performed in the United States. Heavy metals present in minor quantities in a vast number of materials, become concentrated in the dust generated during processing of these materials. The finest dusts, aerosols, go through the dust control systems and easily penetrate the human organism via respiratory system.

Metals in trace amounts are enzyme activators or inhibitors; thus they can affect and control the metabolic processes. Only recently it was established that elimination from the biosphere of the mineral components with the properties of chelation of toxic elements favors injuries to the structures of cells and organs [1].

Relatively most is known on the effect of lead upon the environment. The lead in air, water and soil stems from industrial emissions and automotive exhausts. One study reports that the lead contamination of plants by the Lausanne-Geneva superhighway reaches 150 m off the road verge. Some 5 m from the roadway 33.7 to 103.6 ppm lead per one kilogram of dry weight of vegetation was found. With the distance from the roadway the amount of lead in plants was gradually decreasing.

Measurements carried out in Cracow showed that lettuce picked up 10 m away from an intersection of busy streets contained 28.5 ppm Pb per

1 kg of dry weight. Soils featured by high lead accumulation are dead waste land, as they lack microorganisms active in the nitrogen metabolism. In the presence of calcium lead is less assimilated by plants. Lead enters the animal organism, among other things, with food. For instance, when feeding cows on lead-rich hay the level of this metal in milk was found to increase from 0.024 to 0.074 ppm/l.

In people not occupationally exposed to lead the amount of this metal in blood averages 0.08 mg/100 ml. Absorbed from water or air it accumulates mainly in bones (as tertiary phosphate $Pb_3(PO_4)_2$), next in liver, spleen and kidneys. The fact that lead may cause brain damage is particularly dangerous for children and youth. This is one of the reasons why schools and kindergartens should not be localized by busy streets and roads. Other adverse effects of lead on humans are injuries to hematoietic system, stomach ulcers, kidney neoplasms, etc.

Another example of a highly harmful metal is mercury, which also accumulates in the organism, chiefly in kidneys and brain where it destroys nerve cells, resulting in serious disorders.

The source of air contamination with mercury are smokes from coal combustion. The amount of this metal there is actually minute. Nevertheless, this is estimated at ca. 1000 tons on the world's scale. Crude oil combustion and industrial production introduce into the atmosphere even more of this metal. An estimated 50% of the mercury used by industry goes to the environment, being about 5000 tons annually.

The main route through which mercury gets into the organism is water. As one of the numerous examples may serve the observation that as a result of industrial effluent discharge to rivers from papermills in Sweden freshwater fish in that country contain 50 times more mercury compared with other countries. Hence mercury gets into human organisms by consumption.

As concerns other metals, according to investigation by Berg and Burbanek, an increased nickel concentration in water promotes oral cavity cancers, whereas beryllium in test animals causes bone cancer.

Recently cadmium is increasingly indicated as being not indifferent for human health. According to the opinion now popular in America, this metal plays a role in etiology of cardiovascular diseases. The cadmium content in kidneys in hypertensive disease was found to exceed the average. American students report by way of illustration that if average mortality of heart diseases is assumed as 100 (after elimination of rheumatic reasons), for Chicago, where cadmium content in airborne dust is relatively high (averaging $0.061 \mu\text{g}/\text{m}^3$), the mortality is 126.

Not all metals, however, exert an adverse effect on health. It was found for animals that magnesium-deficient diet triggers lymphatic leu-

kemias. Also, more and more evidence appears to suggest that atherosclerosis is caused not only by cholesterol but also by magnesium deficiency. This is an example of a beneficial effect of a metal.

Selenium and cobalt, like antioxidants in general, prevent the carcinogenic activity of free radicals, which are in these days blamed with being highly active in the development of neoplasms. Iron deficiency results not only in anemia but also in nail fragility, shedding of hair and, in the first place, neuroses.

Certain metals exhibit a preventive effect in dental caries. These are: aluminum, molybdenum, and titanium. The opinion on the role of fluorine in caries prevention has recently raised some controversy. Iodine deficiency is responsible for tumorous hyperplasia of thyroid gland. Copper and selenium deficiency promotes neoplastic diseases, lithium deficiency is linked to psychoses, whereas cobal deficiency is held responsible for anemia-type diseases. Arsenic is an antidote against selenium. The antagonism observed between metals is of practical significance, as it facilitates the leaching of some metals from the environment by others. For instance, magnesium ion lowers toxicity of lead and facilitates its removal from the organism. A similar behavior is known for manganese toward beryllium (after J. Aleksandrowicz).

A temporary decrease in the level of trace elements in the organism is due not only to their insufficiency in food but also results from such factors as the residence in the range of ultrasounds, emotional stress, etc.

As seen from the above, the interest in the presence of metals in the air is fully justified. This problem is the subject of investigation for several years at the Air Pollution Control Division of the City of Warsaw Voivodship Sanitation Department. For the metal industry in Warsaw is represented by about sixty manufactures, in the first place "Warszawa" Metallurgical Plant, a Rolling Mill, "Polfer," numerous printing houses, and many others.

Research Project

In years 1969 till 1973 the percentage of metals in fallout dust was measured at 56 measurement stations. The metals studied included: copper, manganese, chromium, lead and iron. The first four metals, as discussed above, are toxic. A relationship was found between the localization of industry and the air contamination with metals. Comparison of the results obtained in individual years from 1969 till 1972 gives a similar picture of the metallic pollution distribution in the city. Independent of weather conditions which were different in particular years similar results are obtained for metal concentrations measured at the stations exposed

to the emissions released from industrial plants.

The following concentration ranges were noted for individual metals in fallout dust, in ‰:

Fe — 1-10,

Cu — 0.1- > 1.0,

Pb — 0.01- > 0.2,

Mn — 0.01- > 0.2,

Cr — 0.01- > 0.03.

On the basis of results of the measurements maps were prepared for the occurrence of the metals examined in five districts of the left-bank Warsaw.

Chromium. The highest chromium percent in fallout dust was found east and west of the "Warszawa" Metallurgical Plant, where this metal exceeded 0.03 mg/100 mg dust. In other city districts the chromium content in the dust deposit ranged from zero to 0.01‰. The presence of chromium in urban areas is probably due to the large number of major and minor electroplating plants at various manufactures. These discharge chromium but none is equipped with pollution control devices.

Manganese. The highest concentration (above 0.2‰) was observed by the "Warszawa" Metallurgical Plant. In other city districts the manganese content ranged from 0.01 to 0.1 mg ‰.

Copper. High copper concentrations (above 1‰) were established in the dust in Ochota, Wola (a junkyard) and near the "Warszawa" Metallurgical Plant. On average in the city the copper content in the dust amounted to about 0.2‰.

Iron. Contamination with iron was appreciable all over the city. The highest (from 6 to 10‰) was near the "Warszawa" Plant, in Wola, Ochota, as well as in north Mokotów. At other stations the iron content varied from 2 to 3‰. The influence of the "Warszawa" Metallurgical Plant reaches the verge of the Kampinoska Forest, where in the dust fallout the presence of all these metals examined was established.

Lead. With the exception of the area in Bemowo and the Młociński Forest, where the least lead contents were noted (from 0.01 to 0.05‰) over the remaining areas the concentration was on a level of 0.1‰. In Śródmieście, north Mokotów and Wola the lead content was 0.2‰ possibly due to heavier traffic there [2].

Even though the method of determination of metals in fallout dust is inadequate to permit comparison of the results with the standards, it was good enough for comparison among individual city districts and for indication of the most affected ones. A continuation of the previous investigations not reported here are the measurements of metal concentrations in airborne dusts conducted currently. An advanced analytical technique

was used here, notably atomic absorption spectrophotometry, with the help of a Perkin Elmer model 300 instrument. The instrument was made available by the Academy of Agriculture in Warsaw.

Operating Principle of the Spectrophotometer

The atomic absorption spectrophotometer Perkin Elmer 300 is a single-beam instrument with a chopper that modulates the light source, and with a selective synchronous amplifier for frequency modulation. A specific light source provides light of wide spectral range. A sample in the form of a solution is introduced into a flame positioned on the optical axis of the apparatus. In the flame the sample undergoes thermal dissociation into individual atoms. The atoms thus produced are in their ground state and absorb light of a characteristic frequency or wavelength from the light emitted by the specific light source. The extinguished spectral line is determined in the spectrum produced by a grating monochromator and the concentration of the element under analysis is found from the extinction value measured. Extinction is proportional to the concentration of the given metal in the sample. Determinations were made using air-acetylene mixture at a flame temperature of about 2300°C. The routine analysis yields a variance coefficient from 0.5 to 2%.

In the initial stage of the study attempts were made to determine metals in dusts collected for 24 hours on Whatman-4 4-cm paper filters. As in the 24-hr sampling insufficient dust was arrested on the filter, the sampling was conducted for a week to gather enough material for the determination of the metal. The volume of the air passed through the sampler was then about 3.5 m³. In these samples merely copper and zinc were detected.

In the same material collected for a month the detected amount of metals was as follows: copper 0.05 to 0.63 ppm, iron 0.1 to 0.28 ppm, zinc 0.1 to 2.41 ppm; in some of the samples also manganese was found. The volume of air passed there was 13 to 17 m³.

It was realized that at that stage of determination of metals dust sampling should be made by a rapid sampling technique using a Staplex high volume air sampler.

Procedure

Dust-laden samples were collected with a Staplex apparatus on 10-mm in diameter FPP-15 fabric filters for 20 min. The volume of air passed there was equal to about 25 m³. Air sampling for 20 min allows to compare the results obtained with pertinent standards. Subsequently, the

filters were charred in a muffle furnace at 450°C and then treated with a 3:1 mixture of hydrochloric and nitric acids. After the metals were converted to water-soluble compounds, the residue was treated with 10 ml of water, the resultant solution was made acidic to pH ~1 and the metals were determined in the Perkin Elmer 300 spectrophotometer upon suitable dilutions. The acids used were of spectral purity grade and water was triply distilled from quartz glassware.

Measurements were made at 21 stations in various city districts. Considered were both residential areas, like Bródno, Wrzeciono near the "Warszawa" Metallurgical Plant, the near Żoliborz, as well as traffic routes and, for comparison, vegetation-rich areas: Łazienki Park and Powsin.

The study was conducted from April 20, 1975 to January 1, 1976. It follows from a complete listing of the data obtained that individual elements occurred in the air in the following average ranges, in $\mu\text{g}/\text{m}^3$:

Zn — 0.1–0.6,

Cu — 0.08–0.21,

Mn — 0.11–0.42,

Fe — 0.22–12.3,

Mg — 0.22–2.51,

K — 0.27–1.65,

Ca — 2.1–16.5,

Pb — 0.07–1.2,

Cr and Ni — ~0.02 and defined as traces.

In the material collected lead could be determined only in single cases. This results from a low detectability of this element which in the method used is 1 $\mu\text{g}/\text{ml}$ sample. Because lead is a commonly occurring metal in high-traffic cities and in view of its notable toxicity, the data on lead concentration in the air must be known.

The method of inverse chronoamperometry, whose lower detection limit for the amalgam-forming metals is of an order of 10^{-9} mole/l, would allow to determine lead in concentrations encountered in the city in 20-min samples [3]. However, with lots of determinations and a more rapid analysis with the help of the atomic absorption spectrophotometer, it was decided to use a Staplex sampler operated for 3 hours with Whatman-4 filter paper and a large 200×300 mm screen. The volume of air aspirated there ranges from 230 to 300 m^3 , being therefore ten or so times higher than in the case of previous samples. The analyses performed showed that all the metals of interest inclusive of lead can be determined. Of the 21 stations where 20-min samples were collected six were chosen which were the most representative as concerns the distance from manufactures and vehicular traffic. For comparison also green areas were considered,

notably Łazienki Park and Powsin. The analytical procedure was identical as with the FPP-15 fabric filters. A total of 481 analyses were made.

It results from a comprehensive listing of the measurement values obtained that in the case of 3-hr samples the following metal concentration ranges were observed, in $\mu\text{g}/\text{m}^3$:

Zn — 0.2–0.8,
Cu — 0.04–0.18,
Mn — 0.02–0.14,
Fe — 0.7–5.6,
Pb — 0.07–0.8,
Mg — 0.6–1.4,
Ca — 1.5–11.7,
Ni — traces.

Analysis of the results shows that the least metal concentrations occur in the near Żoliborz, Powsin, and in the Łazienki Park, while the highest ones occur in Wola, and Praga (Towarowa and Targowa Streets). The measuring station at Towarowa Street is influenced by metallurgical and electronic industries as well as by printing houses (R. Luksemburg Plant, L. Waryński Works, Rolling Mill, the Mint, etc.). At this station the highest average of manganese for the city was observed, the value similar to that recorded near the "Warszawa" Metallurgical Plant. In that area maximum iron concentration was also noted. The Targowa St. station is affected, in addition to the nearby works, also by the prevalent winds in Warsaw, the westerlies, which bring the emissions from the Wola district.

The highest lead concentrations occur, as expected, at the stations located by major traffic routes, i.e., by the Łazienkowska Expressway and the Nowy Świat Roundabout. The occurrence of considerable amounts of a given metal at a measuring station is not necessarily always due to the vicinity of a manufacturing plant, as another reason may be a remote emission source.

Cited for comparison here are the data on the metal content in the atmospheric air in an American city, after Atomic Absorption Newsletter of 1969. The determinations were carried out with a Perkin-Elmer model 303 instrument [4] (Table 1).

In the listing issued by the Ministry of Health and Social Welfare on the threshold limit values for the protected zones, the 20-min values for the elements under investigation are as follows, in mg/m^3 :

Zn — 0.05,
Cu — 0.01,
Fe — 0.6,

Mg (as MgO) — 0.6,
Mn (as MnO₂) — 0.03,
Cr³⁺ (as Cr) — 0.02.

Inspection of the listing values shows that the standards are not exceeded.

Table 1
Metal Concentrations in the Atmospheric Air [4],
 $\mu\text{g}/\text{m}^3$

Metal symbol	Concentration range
Cd	0.002
Cr	0.018-0.034
Cu	0.5-0.7
Pb	0.5-1.1
Mn	0.033-0.069
Zn	0.2-4.7
Co	0.004

Conclusions

1. The metal pollution of the atmospheric air in Warsaw is due to the presence of a large number of industrial plants located both downtown and on the outskirts, as well as to motor vehicle traffic.

2. Measurements of the metal concentrations in the fallout dust demonstrated an unquestionable influence of the "Warszawa" Metallurgical Plant upon the city. This suggests that the studies on the metal concentration in suspended dust over the areas adjacent to the plant should be extended.

3. Differences in the concentration ranges of individual metal contaminants obtained from 20-min and 3-hr samples result from unequal number of measurements made, which was much larger for 20-min samples. Not until the investigations are extended to obtain sufficient data, a statistical approach will be possible along with the finding to what an extent individual Warsaw districts differ in this respect.

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Dutkiewicz, T.*

TOXICOLOGICAL ESTIMATION OF THE ATMOSPHERIC AIR QUALITY

(Toksykologiczna ocena jakości powietrza atmosferycznego)

The effect of pollution of various environment elements upon the quality of atmospheric air is discussed in terms of four cases of the so-called combined effect of pollution. Formulas are given for the calculation of the area hazard index.

Atmospheric air is one of the major elements of the natural environment of man, and for that reason its quality must be constantly checked upon. This is quite an involved task because of a complex composition of emissions released into the atmosphere.

The qualitative and quantitative parameters of the air have to be considered in the spatial and temporal system. Additionally, meteorological factors not only modify the effect of deleterious influence of the air pollutants but they may affect composition of the latter, as they control the nature and kinetics of the photochemical and catalytic reactions that occur in the atmosphere.

One of the branches of toxicology, the science of poisons, according to the needs of these days, is the rapidly growing environmental toxicology. This science faces a vast number of problems, and its range is as wide as the adverse effects of the environmental poisons reach. Unfortunately, the range of the influence and the number of poisons that surround man is ever increasing. In this connection, the environmental toxicology is facing more and more new tasks and problems needing urgent solution. This science's scope embraces the basic elements of the environment which are air, water, food, and soil. The former three are directly linked to the man's environment; additionally soil has a substantial effect on plants inclusive of those which are a source of food for humans and animals.

*Environmental Protection Center, Katowice,

Just like in industrial toxicology, also in environmental toxicology the main activity resolves itself into prevention, i.e., counteracting the poisonings. For a sound accomplishment of this task, however, a correct estimation of the situation is required by evaluation of the poisoning hazard for individual population groups. This can be done merely by a comprehensive approach to the poisoning problems with due regard to the poisons coming from all the environment elements. It will be noted that the detection of environmental poisoning is not a simple matter, as merely in singular cases, evident deviations from health standards can be observed in individuals. In this connection, the estimation is generally made on the basis of statistical examinations of large populations. The troubles with poisoning diagnoses stem from the fact of a fairly low doses of harmful compounds involved, which, however, are exerting their effect over very long periods. In view of the above reasons, the estimation of poisoning hazard is of great significance, which resolves itself into the appraisal of the conditions under which hazard and probability of poisoning are involved.

A measure of the health and life hazard of man is a total dose of the toxic compounds absorbed. Here all the sources of origin and occurrence of such compounds should be taken into account, including all the routes of absorption (respiratory system, skin, alimentary duct). A rather common phenomenon is the penetration of toxic compounds from one environment element to the others. This is true of the most common harmful substances which occur in air, water, soil, as well as in food. For instance, nitrogen compounds, which increasingly appear in the air as nitrogen oxides, occur in water, soil and food as nitrates, nitrites, and in food additionally as nitrosamines — alleged carcinogens. Nitrosamines are produced as a result of a reaction of nitrites with amino acids. Hitherto these compounds were found in food. Indications are, however, that the nitrogen oxide and nitrogen dioxide present in the air are able to nitrosate secondary and tertiary amines to *N*-nitrosamines in living organisms.

The yield of these reactions is unknown, but there is some evidence that even at the nitrogen oxide concentration in the air of an order of the sanitary standards (in Poland 0.2 mg/m³) the *N*-nitrosamines are formed in the system in quantities sufficient to produce carcinogenic effects [1].

Sulfur oxides occurring in the air result in sulfuration with concomitant acidification of other environment elements — water and soil.

Similar is the case of numerous toxic metals found in the air, such as lead, cadmium, mercury, arsenic, selenium, manganese, chromium, beryllium, copper and many others. Some of them have the property of

accumulation in the vegetable or animal system, which substantially enhances the hazard. It should be emphasized that occasionally toxic metals enter the man's system as much more toxic organic compounds formed as a result of the biological cycle conversions on the route: air — soil — water — plants — animals. This is the case of inorganic mercury compounds which not infrequently occur in foodstuffs as a highly toxic methylmercury ion. Compounds of some metals like beryllium, chromium, arsenic, nickel or uranium also exhibit carcinogenic activity.

Equally dangerous contamination of all the environment elements is with polycyclic aromatic hydrocarbons that exhibit a carcinogenic property. The tagging compound is 3,4-benzopyrene. In the atmospheric air this compound occurs as a result of coal and liquid-fuel combustion (internal combustion engines) and it is present mainly in the finest dust and soot particles. This compound is produced in considerable amounts in coke production. In the air of Polish cities its concentration ranges from 0.029 $\mu\text{g}/\text{m}^3$ in Warsaw to 0.133 $\mu\text{g}/\text{m}^3$ in Zabrze [2], the sanitary standard being 0.05 $\mu\text{g}/\text{m}^3$. In the tap water 3,4-benzopyrene was detected in 1-2 $\mu\text{g}/\text{m}^3$ concentrations, and in marine plankton up to a few hundred microgram per 1 kg of dry weight. In food the highest quantities of this compound were detected in hot smoked fish, the values being 8.5 $\mu\text{g}/\text{kg}$ and up to 10.5 $\mu\text{g}/\text{kg}$ in smoked sausages. What is worse, 3,4-benzopyrene from contaminated air deposits on vegetables and fruit, where it is not infrequently found in concentrations up to 24.5 $\mu\text{g}/\text{kg}$. There are some reports on its presence in cereals and bread [3].

Even if the considerations of the toxic hazard are confined merely to one environment element, air, it should be borne in mind that there occur a vast number of harmful compounds. For that reason, for a correct estimation of the hazard the combined effect of these compounds must be considered.

The Combined Effect of Pollutants

If one considers the situation in which a number of toxic compounds are simultaneously absorbed by an organism, the effect of these compounds may be resolved into the following four cases:

- independent effect,
- cumulative effect,
- antagonistic effect,
- synergic effect.

In practice the most common is the cumulative effect. Sometimes we have also a synergic effect, but very seldom the independent or antagonistic one.

In relation to the toxic air pollutants, the fact that a combined effect of the cumulative or synergic type may be involved is of significance in particular in the interpretation of results of measurements. This has manifested itself in the regulations in force in the USSR pertaining to sanitary standards (SN-245-71). The regulations define the mixtures of compounds exhibiting a cumulative effect, e.g., sulfur dioxide-nitrogen dioxide, or sulfur dioxide-sulfuric acid aerosol, etc. In the case of co-existence of these compounds in the air, the criterion for how many times the sanitary standards are exceeded is based on the following equation

$$A/TLV_A + B/TLV_B + \dots N/TLV_N \leq 1$$

where

$A, B, \dots N$ — the measured concentrations of individual compounds in the air,

$TLV_A, B, \dots N$ — the threshold limit values of the respective toxic compounds.

Some experimental data from investigations with humans and animals point to a synergic effect. This was found for sulfur dioxide in the presence of dust and nitrogen oxides [4]. Also reporting on this is Larsen [5] who obtained a high correlation between the excess death number during particularly unfavorable weather conditions and the product of sulfur dioxide and dust concentrations in the air.

Numerous studies indicate an exceptional harmfulness of industrial dust combined with other air pollutants (sulfur oxides and nitrogen oxides, hydrocarbons). There the effect on living organisms is markedly enhanced, so that the term "nontoxic dust" occasionally encountered should never be used to any kind of dust. A simplified picture of the mechanism of the joint effect of dust and other pollutants in the air may be viewed as consisting in that fine dust particles of developed surface may absorb liquid or gaseous toxic compounds in considerable quantities. Then in that condensed form the compounds can more strongly and efficiently attack the mucous membranes and lung tissue, their removal from the system being more difficult.

It follows from the above data that the combined effect of pollutants should always be taken into consideration in the appraisal of the atmospheric air quality.

The Hazard Indices

Estimation of the poisoning hazards is based on the determination of the poison dose absorbed. In practice, however, the hazard is estimated in terms of hazard indices, which in a better or worse way reflect its value, as they are always correlated to the doses absorbed.

The most common hazard index for toxic compounds in the atmospheric air is the concentration of a given compound. The index can also be referred to as population hazard index as it indicates the hazard of large populations in the area under investigation. This index accounts also for toxicity of individual toxic compounds, because the concentrations studied are compared with the sanitary standard values (threshold limit values) whose numerical value is inversely proportional to the toxicity of a given compound.

Another index, based on the investigation of the concentration of poisons in systemic liquids, is individual hazard index. With its use hazard of individual persons examined can be estimated, and occasionally even the daily dose absorbed can be evaluated.

Neither of the above indices, however, is universally good for the appraisal of the combined effect. This is because many measurements are required which in most cases is impracticable in view of still insufficiently developed measurement network and with the scarce toxic species that can be determined in the air and in systemic liquids. It appears, therefore, that in some cases, especially when not too an exact toxicological characteristic of rather large areas is required, not the ground level concentrations of pollutants but the emission rates could be used as a basis. Similar approach has been suggested for the determination of the toxicity of automotive emissions [6]. The authors there recommend the determination of all the components of the motor exhausts under examination.

The Combined Hazard Index for an Area

As distinguished from the exposure hazard indices based on the emission rate of the toxic compounds and on the exposure of individuals to these compounds, the combined hazard index for an area is related merely to the emission of toxic compounds into the atmosphere, and determines only the potential poisoning hazard. Despite that emission rate is linked to ground level concentration, this relation is not always simple for a given area. For that reason, the hazard index is not necessarily adequate as concerns the actual exposure of population of the area under consideration. An advantage of this index is that all toxic compounds involved can be accounted for, even if the emission values would be roughly known. In this manner the combined effect of the substances under examination can be estimated. Calculation of the index for individual compounds makes it possible to compare and point out the most harmful emission. The index may be calculated on the basis of the emission rate for an area (ton/km^2) per year E , with an account of the toxicity factor of the compound in point T based on the threshold limit values, and whose

value is, to the first approximation, inversely proportional to the toxic effect. The area hazard index AHI is, therefore, a quotient of the area emission rate and the toxicity factor T of a specific compound

$$AHI = E_o/T$$

Value of this index will increase with the emission rate and toxicity of pollutants considered.

To give an example, if dust emission on a definite area is 88 tons/km² per year, the area hazard index for dust AHI_d will be

$$AHI_d = 88/(0.2 \cdot 100) = 4.4$$

Likewise for the annual SO₂ emission equal to 50 tons/km²

$$AHI_s = 50/(0.35 \cdot 100) = 1.7$$

The threshold limit values for dust and sulfur dioxide are 0.2 and 0.35 mg/m³, respectively. The values are multiplied by 100 in the denominator to obtain integer numbers for the index.

The area hazard index has the main advantage over the area emission rate that it accounts for the harmfulness of a given substance, directing thereby our attention to where the situation is dangerous. The index is not, however, an absolute quantity, although it could become one as soon as the emission standards are set up.

Considering the total value calculated for individual compounds, the value of the combined area hazard index is obtained which accounts for all the data required for a comparative evaluation of pollutants.

For the Upper-Silesian area the AHI value was calculated on the basis of the area emission rate in individual regions for 1972 [7] (Table 1).

The Area Hazard Index in Industrial Regions of Upper Silesia

Table 1

Region	Area hazard index			Combined area hazard index
	NO _x	SO ₂	dust	
GOP-1	6	14	28.6	48.6
GOP-2	0.75	1.9	3.5	6.15
CzOP	0.25	0.25	3.4	3.9
ROW	0.7	1.3	3.7	5.7
OBC	0.23	1.63	2.3	3.16
The whole area of the Katowice Voivodship	0.75	1.7	4.4	6.85

GOP-1 — urban Upper-Silesian Industrial Region

GOP-2 — urban and county: Gliwice, Tarnowskie Góry, Będzin

CzOP — Częstochowa Industrial Region

ROW — Rybnik Coal Region

OBC — Bielsko-Cieszyn Region

It follows from the table that the hazard for particular industrial regions is not the same, the urban Upper-Silesian Industrial Region standing out unfavorably. Of the three toxic compounds compared, the highest hazard comes undoubtedly from the dust, which is in a way desirable in view of the fact that the dust emission control technique is fairly advanced today. Ranking in the second place are sulfur oxides, followed by nitrogen oxides. It should, however, be borne in mind that the latter stay airborne for a much longer period, which eventually may result in much higher concentrations. When comparing individual industrial regions in terms of the combined area hazard index one can draw a conclusion that the situation in the GOP-1 region is roughly sevenfold worse than the average for the area under examination. On the other hand, the lowest hazard, about a half of the average, has been found for the Bielsko-Cieszyn Industrial Region and the Częstochowa Industrial Region.

It appears that an analysis of the situation based on the area hazard index value may provide a clearer picture to be used in properly guided endeavors to improve the actual state.

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PATENT REVIEW

A Demisting Device

Inventor: J. Kwaśniak

Patent owner: Technical University of Łódź

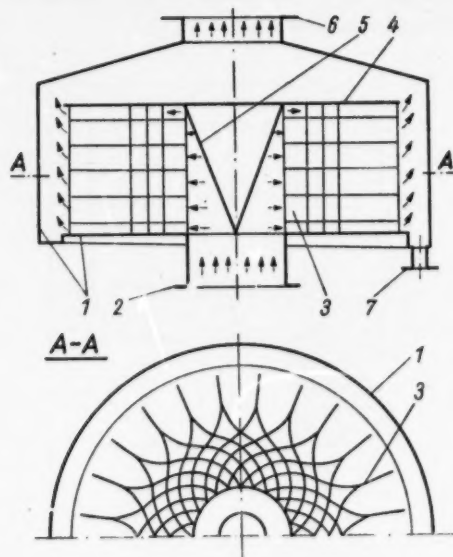
Filed: December 11, 1973

Cl. internat.: B 01 d, 45/08

No.: 79895 (provisional)

The subject of invention is a device for the removal of liquid aerosol from gas streams, particularly those whose droplet diameter is below 10 μm . Hitherto for gas demisting mist eliminators are used in which the working part is a package of corrugated plates in a parallel arrangement and spaced at definite intervals. In such mist eliminators the gas stream paths deviate alternately, which results in that the droplets, which fail to reach the plate wall at one deviation, will be in the least favorable position with respect to the next deviation of the gas stream path, thereby lowering efficiency of the mist elimination process. For the mist eliminators of prior art there is such a value of gas flow rate at which the liquid is reentrained from the walls into the gas stream, with the resultant substantial decrease in demisting efficiency. The demisting device according to invention consists of a housing 1 in the bottom of which the coaxial gas inlet tube 2 is provided. Accommodated inside housing 1 between two cylindrical surfaces of a common geometric axis is the pack of vertical baffles 3 that come from the inside cylinder surface, said baffles being shaped along the involute and with equal pitch. Cover 4 is placed atop baffle pack 3 with a cone 5 pointing with its vertex in the direction opposite to the direction of gas entrance. Cone 5 is designed to distribute evenly the gas stream among all the baffles 3. At the other end of housing 1 an outlet tube 6 is coaxially provided for the discharge of demisted gas, whereas in the housing 1 bottom tube 7 is placed to let the liquid condensate out. The gas stream to be demisted, fed through inlet tube 2

into demister, is distributed by cone 5 among baffles 3 radially where, in the space contained between the baffles, owing to the imparting of momentum between the gas streams in the direction perpendicular to the stream flow, the liquid drops coalesce, fall down and drip to the housing bottom, wherefrom the liquid is discharged through tube 7, and the demisted gas is let out through tube 6.



A Rapping Mechanism for the Filterbag Fabric Cleaning

Inventor: L. Pawłowicz

Patent owner: "Lenin" Metallurgical Plant, Cracow

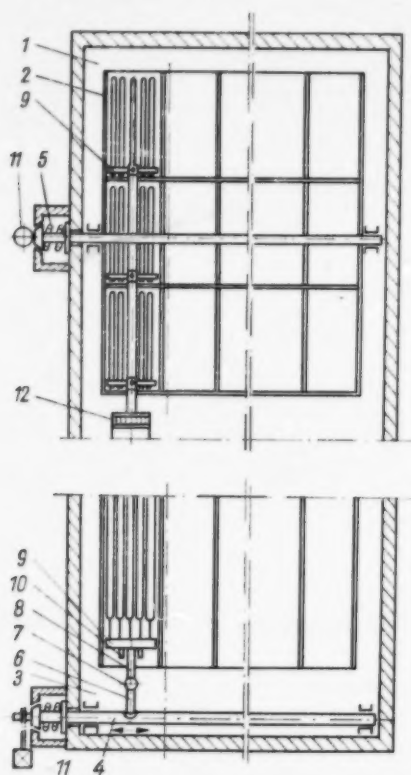
Filed: September 26, 1974

Cl. internat.: B 01 d, 45/08

No.: 84684 (provisional)

The object of invention is a device for mechanical cleaning of filterbag fabric from the deposited dust on the surface of filter element, especially from the Dynaclone filter fabric. Chamber 1 accommodates fabric filterbags 2 and encloses space 3. Space 3 houses vibrating shaft 4 with spring 5 and lever 6 mounted on pivot 7. Lever 6 ends with a pushrod 8 and bar 9. A clamp 10 and filterbags 2 are attached to bar 9. The vibrating shaft 4

is motor powered 11 and pivot 7 is mounted in a thrust bearing 12. The invention operates as follows. Upon preliminary cleaning of bag filter fabrics 2 by air reversal, the emission control line is cut off. The electric motor 11 is then switched on, and its cam makes the shaft 4 vibrate. The vibrations produced by shaft 4 are transferred via lever 6, pushrod 8 onto bar 9 to which filterbags 2 are clamped. Vibrations of the fabric cause all the deposits to dislodge and fall down which, collected in hopper, are subsequently discharged from the filter.



A Hydrocyclone

Inventors: B. Lekston, F. Stolarz

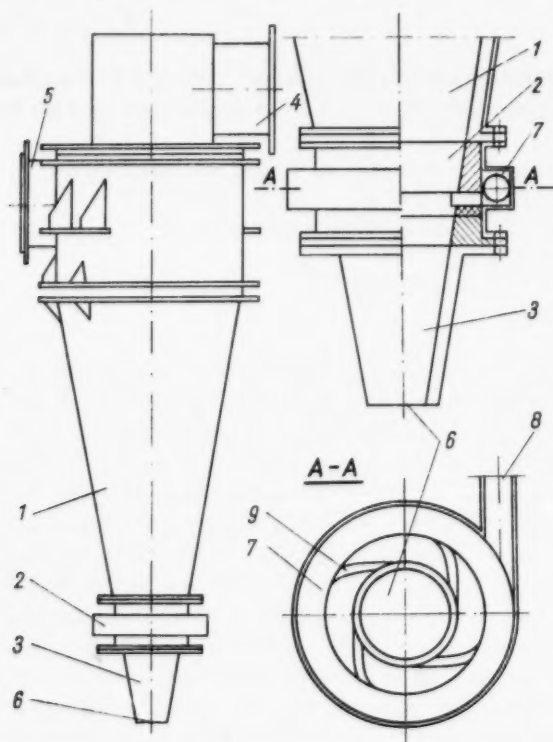
Patent owner: "Bipromet" Nonferrous Metals Industry Designing Office, Katowice

Filed: June 7, 1972

Cl. internat.: B 01 d, 21/26

No.: 74984

The subject of invention is a hydrocyclone with liquid separator, designed to separate solids of various specific gravity in heavy liquids. The hydrocyclone according to invention in the example of execution is shown in the figure. The hydrocyclone incorporates shell 1, liquid separator 2 and nozzle 3. In the hydrocyclone shell 1 head there are an overflow tube 4 and inlet tube 5, whereas outlet hole 6 is provided in nozzle 3. On the periphery of separator 2 there is a flow chamber 7 with water supply



tube 8, said chamber is connected by means of guide vanes 9 with opening 6 in shell 1. Guide vane 9 inlet ports are formed normal to the flow chamber 7, and their outlet ports are normal to opening 6 in shell 1. Hydrocyclone operates as follows. The feed is delivered through tube 5 to hydrocyclone head. The feed, owing to a rotary motion, separates into

the outflow and overflow. Outflow constitutes a mixture of the heavy liquid and heavy material while the overflow consists of the heavy liquid with the material lighter than the outflow material. On account of the rotary motion of the feed the outflow considerably thickens. Then an additional controlled water stream added to the separator 2 expands the outflow before its leaving the nozzle 3 and, as a result, the remainder of the lighter material in the outflow coming up enters the overflow. The additional controlled water stream fed to separator through tube 8 goes to flow chamber 7 and, subsequently, via guide vanes 9 flows into opening 6 in shell 1 following the rotary motion of the feed.

**A Method for the Removal of Airborne Contaminant
from Gases and a Device for the Application of This Method**

Inventors: M. Sokolowska, A. Kielsa, J. Markiewicz,
Z. Gulczyński, J. Górnicki

Patent owner: Warsaw Technical University

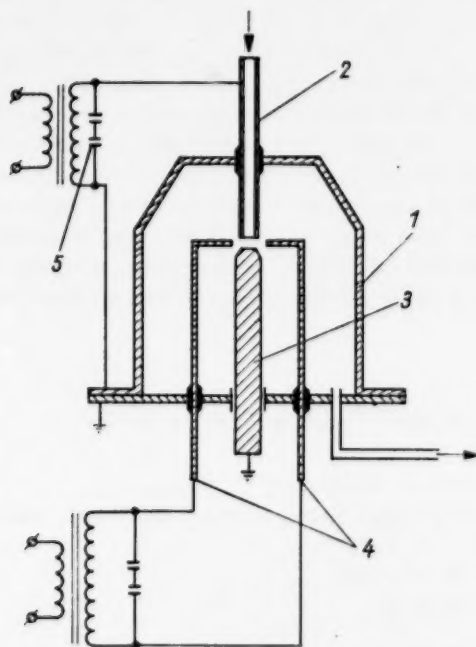
Filed: June 29, 1971

Cl. internat.: B 01 d, 53/32

No.: 77644

The object of invention is a method for the removal of airborne contaminants from gases and a device for the application of this method, especially if used for the cleaning of gases employed as a protective atmosphere in heat treatment of metals or in the manufacturing and purification processes for semiconducting materials. The method and the device are applicable wherever manufacturing processes require gases of a contaminant concentration not higher than 1 ppm, especially if a large stream of clean air is desired possibly under a pressure higher than 1 atm. In the case gases are cleaned of vapors (e.g., hydrocarbons and water vapor) the recognized techniques consist in sorption of these vapors by active carbon, silica gel, zeolites or other sorbents. To remove gaseous contaminants from gas streams, e.g., removal of nitrogen from argon, a known procedure is to treat these gaseous impurities with substances that react with these impurities at an elevated temperature as, e.g., liquid lithium, calcium or magnesium, barium, and the products formed from combination of these impurities with the substance used can be easily isolated from the gas cleaned. Thus a widely recognized method is the removal of oxygen from other gases by causing it to react with copper to form cupric oxide. In the application of chemical methods of gas purifi-

cation from volatile impurities the maximum degree of purification and large streams of pure gas under atmospheric or higher pressure are limited by the following two factors: the reaction equilibrium constant and the kinetic factor of the reaction in nonhomogeneous system. The purpose of the invention is to eliminate the inconveniences of the methods mentioned, and the engineering objective is to find a method of purification of any gas from any contaminants and to develop the design of a device that would materialize this method to ensure high efficiency of the purification process and a high degree of purity of the gas cleaned of an order of 1 ppm. The method according to invention consists in that volatile gas impurities are made to react with the plasma of the material of at least one of the electrode pair, between which the sputtering electric discharges are produced, preferably in the form of hot sparks. The device for gas purification from volatile contaminants con-



taining at least one electrode pair consists of an airtight chamber 1 equipped with inlet and outlet tube, within which a pair of main electrodes 2 and 3 is accommodated one in front of the other and at an adjustable distance, and at least one pair of auxiliary electrodes 4 which imitate the sputtering electric discharges between the main electrodes, preferably in

the form of a hot spark. The pairs of the main and auxiliary electrodes are connected to independent power supplies, which are a.c. sources with transformers, in the secondary windings of which capacitors 5 or capacitor batteries are connected across the winding. In the device one of the main electrodes 2 or 3 is the gas supply pipe that feeds the gas into chamber 1. Operation of the device according to invention consists in that the gas under treatment is delivered by tube 2 into the inside room of chamber 1, in the area of the tube 2 end, and the electrode 3 and 4 tips. Then the electric discharges are made to occur between the auxiliary electrodes 4, which initiate hot sparks between electrodes 2 and 3, which entails the evaporation of material from the electrode 3 surface to produce plasma. Under the plasma condition the electrode 3 material ions combine with the impurities of the gas allowed to pass through the device at a velocity characteristic of the reactions in a homogeneous medium. Upon passing through the interelectrode space the gas subsequently becomes cooled from a temperature of a few thousand degrees centigrade that is typical of plasma to the temperature prevalent in the remaining part of the chamber, that is, to nearly room temperature. As a result, the nonvolatile reaction products do not undergo redecomposition and are led out along with the gas from the chamber in a recognized manner and arrested in a dust control equipment. In case the gas under treatment contains several kinds of volatile impurities, it is preferable to apply a device train, each individual train unit being equipped with the electrode of the material suitable for individual kind of contaminant, whereby from the last unit of the train gas is obtained that is deprived of all these impurities.

A Dust Emission Control Device

Inventors: A. Fryś, A. Kudliński, B. Trant

Patent owner: Municipal Transportation Company, Warsaw

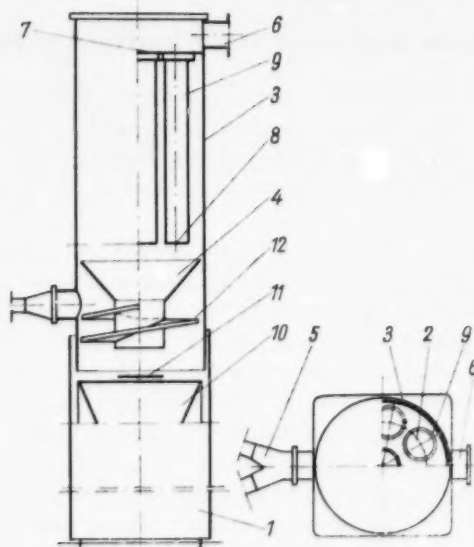
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The subject of invention is a dust emission control device which may find application in all industries. The device in the example of execution is shown in the figure. The device incorporates a cyclone collector 1 and fabric filterbags 2 arranged above the cyclone 1 of the tube 4. Housing 3 of the fabric filterbags is provided with a suction tubes 5 and 6; tube 5 is placed beneath the cyclone 1 of air tube 4, whereas

tube 6 is situated above the fabric partition 7 of housing 3 of filterbags 2. Attached to the fabric partition 7 are filterbags 2 in such a way that their bottoms 8 are positioned above air tube 4 of cyclone 1. Moreover, filterbags 2 are kept in position by ribbings 9. The top cyclone 1 part is equipped with a baffle 10 arranged on the air tube 4 axis of cyclone 1. During the operation the device being the subject of invention is connected to suction nozzles by means of flexible hoses on the tube 5 side,



and tube 6 is attached to an exhaust fan. As the fan is switched on all kind of dusts, matches, cigarette butts as well as used tickets from the municipal transport vehicles are sucked into cyclone 1 through suction nozzles, elastic hose and tube 5. After being rotated in helix 12 of the air tube 4 and having lost its initial speed, part of the contaminants fall down to hopper 10, whereas airborne dusts pass via duct 4 into filterbags 2 where they deposit. Baffle 11 prevents larger-particle contaminants from entering filterbags 2. The cleaning of filterbags 2 is effected automatically by turning the fan on.

Prepared by P.P.

NEWS IN BRIEF

The Soviet Science and Technology Days in Poland

On April 4-24, 1977 the Soviet Science and Technology Days program took place in Poland. The events were organized in Warsaw and Katowice. The exhibits and the meetings of the program were to present the achievement and prospects of the development of the Soviet science and technology.

Achievements of the Soviet Union were presented by individual subjects in such fields as: space science, nuclear science and engineering, electronics, control and measurement instruments, computer science and automated management systems, building industry and architecture, public health, mining industry, power industry, metallurgy, machine building, transportation, chemical and foodstuff industries and nature conservation. Within the framework of the program the individual industry days were held. Considerable attention was paid, among other things, to presentation of the achievements of the Soviet Union in the domain of the natural environment of man. These problems are in focus today, with due regard to the adverse effect of the ever-increasing industry on the environment. The first act, On the Conservation of Nature, Gardens and Parks, was issued in the Soviet Union as early as 1921.

The Soviet Union possesses huge natural resources; all the same, their use should be made consciously and in a planned way, so as not to permit of depletion and devastation of the nature. For that reason, the nature conservation is aimed at its purposeful and conscious transformation. In connection with the increasing interference of man into the secular regularities of the nature and in view of the constantly growing problem of pollution of the natural environment, a number of legal acts have been issued in recent years in the USSR on the environment conservation. The Supreme Soviet of the USSR in its resolution, On the Measures to Continued Improvement in the Conservation of Nature and Reasonable Use of Natural Resources, has defined the problem of nature conservation and absolute observance on the pertinent laws as one of the key tasks for the Government. Among the major problems related to

conservation of the natural environment of man the question of clean air occupies a distinguished place. Soviet scientists have established the threshold limit values for 134 individual compounds and for their 25 mixtures. An all-union committee has been called into existence which was entrusted with the supervision and monitoring of the environment pollution level and with processing of rapid information on air pollution emergency conditions. Apparently, the technological revolution adversely affects the natural environment. On the one hand, the resultant effect of technical influence entails intensification of the negative agency on the surrounding nature; on the other hand, the outstanding scientific and engineering achievements permit the society to employ newer and newer materials and forces of the nature and to meet more fully the human needs. They also permit of improving and restoring the environment and to anticipate ecological crises some suitable time ahead.

The problems exposed in the Soviet Science and Technology Days program and related to the conservation of the natural environment of man together with the achievements gained in this field are evidence of the great importance attached to these matters. The reason for that is to ensure as best as possible the possibly highest living standards for people and to be able to undertake efforts to prevent destruction of the nature or, in other words, conservation of the natural environment of man, primarily by the abatement of atmospheric emissions.

Environment Pollution Control in the Building Materials Industry

On October 5 and 6, 1976 an international scientific and engineering conference was held in Bydgoszcz under the sponsorship of the SITPMB (Association of Engineers and Technicians of Building Materials Industry), Polish Federation of Engineering Associations (NOT) Bydgoszcz Branch, on The Environment Pollution Control in the Building Materials Industry. Participating in the conference were scientists and specialists from brotherly socialist countries and the Polish representatives of research centers, industry, designing offices and the units of administrative bodies concerned with the pollution control problems.

The conference was held in four subject sections, viz.:

Section A — air pollution control, headed by Professor Dr. R. Andrzejewski (Polish Academy of Sciences, Zabrze).

Section B — utilization of industrial waste, headed by Professor Dr. A. Paprocki (Institute for Building Technics, Warsaw).

Section C — environment recultivation and engineering, headed by Professor Dr. J. Siuta (Environment Engineering Institute, Warsaw).

Section D — noise and vibration control, headed by Professor Dr. J. Sadowski (Institute for Building Technics, Warsaw).

The problems included in the conference were presented in the following reports:

Technological Progress and the Permissible Dust Emission in the Building Materials Industry in Poland — Professor Dr. R. Andrzejewski.

In the cement industry the most dust is produced in the clinker burning process. The wet technique of clinker burning used up to now is gradually being superseded by the dry method featured by an increased dust escape. As the dust is of immediate market value, it must be collected in dust precipitators. Thus the electrostatic precipitator becomes a production line unit, whose capacity or efficiency are of equal importance with that of the rotary kiln. In this connection studies are needed on the ways to the possibly highest raising of collection efficiency, as well as on the utilization of the dust collected in the precipitator, which averages a 10% of the output. Dust emission is thereby reduced, which unfortunately, in this country is still nearly eightfold higher than in France and 25-fold higher than in West Germany. Despite a remarkable leap forward, the average dust emission from cement industry corresponds to the Western Europe's level of 25 years ago. The reasons for that are essentially evident. However, without relevant research the problem is hard to be solved.

It is anticipated in the United States that in view of the constantly improving performance of fabric filters, this kind of emission control devices will supplant other high-efficiency control equipment by year 2000. For that reason, research is underway on various fabrics and longitudinal-field electrostatic precipitators. The elimination of dust fallout of particle size below 20 μm is merely a matter of time.

A more involved problem emerges instead, which is precipitation of the Stokes' diameter dusts (below 3 μm), which is present in the dusts discharged by cement plant in an amount of about 43 wt.%. Such dusts are known to deposit in respiratory ducts of man, being an obvious potential health hazard.

The problem of the permissible dust emission rate from cement plants, solved in terms of the ground level concentration values and the dust fallout, is of different character.

The Environment Pollution Control in the VEB-Zementkombinat, Dessau, German Democratic Republic — H. Tschirpke, Eng., H. Kinzel, Eng. (GDR).

The rapid growth of industry results in the production of a vast number of contaminants of the natural environment of man. This calls for a consistent and comprehensive action aimed at reducing the adverse effect on the environment particularly of the industries which, like the building materials industry, emit harmful contaminants in high volumes.

In the GDR building materials industry the major problems in the domain of preservation of clean air are offered by cement industry. The authors discussed dust control equipment used in that industry for some examples of production lines. They also brought up the subject of fruitful cooperation with Institute for Building Bond Materials in Opole, particularly in the field of fabric filters applied in cement industry. The plans related to the solution of the problems with the shaft furnace emission control in the lime industry, in cooperation with the Opole Institute mentioned, were also presented.

In subsequent part of the report the authors dwelt upon the legal aspects of environment pollution control in the building materials industry in the GDR and discussed the organization system in the VEB-Zementkombinat in Dessau and in its subsidiary plants related to the emission control and supervision over the undertakings to improve condition of air purity. Implementation of this system was preceded by the equipping of the subsidiary plant with a unified measurement and control instruments and by making explicit the criteria for the specific measurement taking.

In conclusion it was pointed out that, even though the environment pollution problems in the GDR are approached in a correct way and according to a definite plan, their accomplishment is closely connected with continued progress in technological improvement of the processes used.

Some Engineering and Economical Problems of Environment Pollution Control in the Cement Production by the Wet Process — Laszlo Solyon, Eng. (Hungarian People's Republic).

In the building materials industry in Hungary the highest dust emission should be linked with cement plants. The engineering measures taken to abate the emission have an impact on the economic aspect of the plant's operation. This is the source of the doubts the author brings up in his report, and notably:

— if, and at what cost the permissible standard can be met in view of a limited emission rate from numerous sources,

— if the GLC values cannot be met, what could be an optimum solution, considering the cement plant operating time and availability of the purchase of control equipment,

— the problem of space availability for the control equipment in old reconstructed plants,

— to what an extent the profit is affected by the ratio of mean output value to capital costs,

— the manpower problem.

An extensive study was made on the solution of dust emission control problem, of which the following three variants advanced will be discussed below:

— complete solutions of dust control with some alterations in the production processes and with the use of "Western" electrostatic precipitators,

— solution of dust control without process alterations and with the use of Hungarian-make precipitators,

— application of a multicyclone alone for the control of rotary kiln exhaust emissions.

Dust Emission Control from Shaft Kiln Heaters on the Example of the "Nowiny" and "Malogoszcz" Cement Plants — L. Zimmermann, Eng., K. D. Poleschner, Eng.

The most commonly used emission control equipment for cement kiln emission control are electrostatic precipitators, irrespective of the process adopted (wet, semi-wet, or dry one). These devices ensure the most efficient and economically sound manner of emission control, considering the capital and running costs, reliability, and the actual operating time achieved, as well as maintenance and overhaul requirements.

In view of the rise in importance of the dry process employing shaft heaters, which is the most reasonable process for cement manufacture available, the treatment of the subject was confined in the report to the control equipment for that method.

In view of the characteristic properties of the dust-laden exhaust gases from shaft heaters (high temperature and high electrical resistivity of dust) the gases have to be conditioned by their cooling and humidifying to ensure efficient and economic operation of the electrostatic precipitators. The major relations between the parameters characteristic of the particulate-gaseous medium and performance of the precipitator are graphically shown and discussed in detail, along with the requirements as to the conditioner design.

In the subsequent section of the report the problems of attaining the guaranteed precipitator performance in the "Nowiny" and "Malogoszcz" Cement Plants were presented. The troubles arose during operation of these devices. An approach to solve these problems is also given. In conclusion a number of important remarks were made on the precipitator service.

The Exhaust Gas Parameter Stabilization System for the Dry Process Clinker Burning Kiln Downstream of the Electrostatic Precipitator — A. Łuszczewski, Eng.

The dry clinker-burning process features a high value of dust entrainment and high gas temperature of low gas moisture content. These properties set up difficult conditions for the achievement of high collection efficiency in the precipitator. This effect is enhanced additionally by the fact of high resistivity of the dust which not infrequently attains $10^{12} \Omega \text{ cm}$ and above. The limiting value at which collection efficiency is still high enough is usually assumed as $5 \cdot 10^9 \Omega \text{ cm}$.

One of the manners to improve collection efficiency is humidification and cooling of exhaust gases by means of a direct injection of water into the cold kiln end. Results of a two-year service with the use of this stabilization system in the "Rudniki" Cement Plant for a kiln of a capacity of 680 tons/24 hr demonstrated a higher efficiency of the precipitators. Moreover, the system has no effect on the kiln operation and its output.

Description of the system and of the results of operation are preceded by theoretical considerations on the thermodynamics of the system employed.

Results of the Study on the Prototype Domestic Glass Fabric Filters — L. Kościanowska, Eng., J. Kościanowski, M.Sc. Eng.

The texture of a filtration fabric based on $6\text{-}\mu\text{m}$ glass fiber was developed and tested. The fabric meets the Western quality standards. The performance characteristics of the dust filtration glass fabric, which has already entered the production stage under the commercial mark of ST-7, are tabulated along with the corresponding characteristics of similar French and American fabrics. The testing was carried out on a pilot plant in a fractional scale equipped on the rotary kiln to obtain a dust concentration in the off gases after treatment below 50 mg/m^3 .

Description of the test installation and the properties of the fabric and dusts provides an ample basis for possible use of this fabric for filterbags in cement industry for dust removal from hot exhaust gases.

Utilization of the Furnace Dusts in Cement Industry — Docent Dr. S. Bethke.

The growing amount of dust precipitated in the emission control equipment, reaching today a level of 500 thou tons a year, must be recovered for industry. The value of dust in 1975 amounted to 52 million zlotys. The research effort at the Institute for Building Bond Materials is aimed at utilization of kiln dusts. In the wet process of clinker burning the dust can be recycled to cement production or used otherwise. It may, for instance, be taken in a 10% of cement weight as a cement additive without impairing its properties. Results of the research to date and the trends of continued effort on this problem were extensively treated.

Measurement and Emission Control of Exhaust Gases from the Sintered Lightweight Aggregate Production — Z. Charkiewicz, Eng., K. Roslanowska, M.Sc. Eng.

On the example of a pilot plant production of expanded clay aggregate Glinoporyt™ on a belt sintering machine results of the studies are presented which are focused on finding an optimum solution from the economic and engineering standpoint for the emission control of humid exhaust gases with the removal of tars and dust.

Determination of the above contaminants offered a challenging analytical problem. An experimental setup was developed and the gravimetric method was selected for tar determination in the gas, produced from decomposition of the charge brown coal. A study was conducted on a one-fourth scale on the use of exhaust fan, Venturi tube, and a slit collector, as well as on the application of a variety of scrubbers and tar electrostatic precipitators. The sintering process was also investigated to make some alteration to abate emissions.

The results hitherto obtained failed to allow for the selection of an optimum technique for exhaust emission control.

Air Pollution Control in Quarries and Stone Working Plants — Dörgö Miklós, Eng. (Hungarian People's Republic).

The need for international cooperation in the domain of environment pollution control is covered in this report. Other subjects treated include:

— Description of the Hungarian air pollution regulations. Experiments made in the dust measurement of workplaces in the Hungarian stone working industry were presented and the most interesting results were highlighted.

— Also for wet processes, dust pollution poses health hazard to workers.

- Collection efficiency of emission control equipment was examined for the devices placed directly by the crushers.
- Solutions adopted for dust control in stonework shops are described.
- Recommendations are specified for improved dust control.
- A combined method of dust emission control given involves dust precipitation and heating of working rooms.
- A new solution for dust control in the stone crushing and classification plant is advanced.
- Vacuum pumps are suggested for the cases where a high resistance to air flow must be overcome in the air transport.
- Sluices were used for the disposal of dust collected in dust bins coupled to vacuum pumps.
- Economic problems related to air cleaning in the stone classification and processing plants are covered.

Dust Emission Measurement in Power Plants — J. Kakas, A. Reviczky, and S. Serege (Hungarian People's Republic).

Dust generation and emission control measurements in a power plant are reviewed. The subjects include:

- determination of dust content in exhaust gases,
- emission control devices,
- relations between measurements and engineering problems, measurement site, flow rates,
- dust concentration measurements for engineering, scientific, and operation purposes,
- collection of fundamental data required for the technical and economic estimation of the dust control equipment to be employed.

In each of the cases treated the essential condition for a correct emission rate determination is a conscientious and careful execution of the measurements themselves, as well as a correct qualitative and quantitative evaluation of dust samples collected.

The Air Pollutant Concentration Measurement Systems in the Building Materials Industry Plants — H. Schaffrath, Eng. (GDR).

The report covers the measurement methods for emission rate and ground level concentrations of particulate and gaseous emissions occurring in plants of the binding materials industry in the German Democratic Republic, especially in cement plants.

Operating principles of the most common measurement instruments are discussed, specifying the ranges of the quantities measured and the

measurement procedures. The report is supplemented with schematic drawings of the instruments covered.

The Model Study on the Dust Ground Level Concentration in the Neighborhood of Cement Plants — K. Balazs, Eng., Z. Szalay, Eng. (Hungarian People's Republic).

Environment pollution control is related to investigation and determination of emission rate and dispersal of air pollutants (gases, dusts), which are discharged by emitters and which critically affect the ground level concentration values, especially on industrialized areas. The wind tunnel testing, to a suitable scale and under simulation of meteorological parameters, enables air pollution to be estimated already in the plant conceptual stage.

Pollutant distribution study assumes, on the one hand, the knowledge of meteorological parameters (stability conditions, wind profile, degree of turbulence) and, on the other hand, the application of correct similarity criteria for the model set up in the wind tunnel.

Investigation on the relation between stack height and pollutant concentration observed is covered in the report. The model has been built with due regard to topography of the area, to a proper scale of vertical and horizontal dimensions. Results of the model measurements are comparable with the results of theoretical calculative methods. In the theoretical calculations the topographic data could be accounted for merely as stochastic parameters. Under established boundary conditions the stack height effect and the limiting values of the variables could be determined using the measurement results obtained.

Calculation of the Dispersal and Ground Level Concentration of Pollutants in the Surroundings of the Binding Materials Industry Plants — M. Gębica, M.Sc. Eng.

Formulas used for the calculation of pollutant dispersal in the air are discussed. The author advocates the method which would provide lower precision but it would be less obscure in the general procedure and would ensure comparability. He makes use of the fundamentals of the method referred as CUGW-68 for the development of a calculative procedure of his own which he applies in the BPPCiW Designing Office. The method has been given the name of CW method. The method is useful in general designing particularly in case of large number of emitters of diverse characteristics. The Budziński's principle is assumed which coordinates the coefficients to wind speed values alone with calculation running every 1 m/sec upwards. Calculations are actually done with

a computer, but for a limited number of emitters, graphs can be employed.

The dust fall emitted from numerous sources is evaluated using Krieb's expression, which provides the additivity rule for many emitters.

The calculation method advanced may in some cases prove adequate in replacing the extensive and costly pollution calculations. This method is exceedingly convenient in describing emission and the effect of its characteristics on the criterion air pollution indices.

The Concept of the Automatic Air Pollution Control in the Areas of the Binding Materials Industry — A. Rybarczyk, M.Sc. Eng., A. Jaworowicz, M.Sc. Eng.

A basis for the implementation of automatic air pollution control system is the unification of measurement methods and research instrumentation. The authors suggest implementation of the unification in the COMECON countries. This should concern continuous determinations of meteorological conditions, ground level concentration and emission rate of gaseous and particulate emissions.

The rationale for the information system proposed is discussed with more detailed treatment on the measurement, computer, and measurement and control blocks and their cooperation. The data would be communicated to the users in case the threshold limit values are exceeded as a result of too high a rate of emission by a given plant to improve the situation. Also covered are the conditions for making the system operative. The outlined concept is a preliminary stage for the subject: Implementation of the Natural Environment Information System, entrusted to the Polish party.

A New Fabric for Dry Dust Filtration — J. Kościanowski, M.Sc. Eng.

As a result of cooperation conducted in years 1971 to 1974 between the Opole Institute for Building Bond Materials and the Łódź Textile Goods Central Laboratory, a new polyester fiber fabric of conventional texture has been developed, tested and implemented to industrial practice. The fabric is marked as ET-30 and is designed for the building bond materials industry.

The Role and Prospects for the Utilization of Industrial Waste in Building Industry — Professor Dr. A. Paprocki.

A general classification of mineral waste produced from manufacturing processes of a wide variety of industries is given. The industries specified are: mining, ferrous and nonferrous metallurgy, sulfur refinery,

solid fuel combustion processes and possible use of the waste produced in these industries in the building materials industry is analyzed.

Also covered, in the form of postulates, are the modern trends in the utilization of industrial waste on the example of many countries along with the proposals in this field in relation to individual industries in Poland.

The Industrial Waste Utilization for Building Purposes — Potentialities and Prospects in the Aspect of Environment Pollution Control — Dr. T. Antolak.

The researches presented in the report include:

- general analysis of the selection of research subjects and the course of the studies and implementation of research in the field of industrial waste utilization for building industry, conducted by the units subordinated to a variety of economic departments;

- proposals as to the activity trends for the most efficient use of the domestic waste supplied for the building industry purposes, based on the results of research hitherto obtained in this country and abroad.

Possible Use of the Power Plant Furnace Waste by the Building Materials Industry — Dr. Z. Pietras.

Environment pollution control not infrequently requires integrated interindustrial effort. The cooperation of power industry with the building materials industry may be an example of a preventive activity of double significance. On the one hand, the annoying and area-occupying industrial waste is eliminated, on the other hand, the generally used strip mining in the winning of some materials for the building materials industry can be substantially diminished.

The report specifies the kinds, properties and classification of the domestic furnace wastes of professional power industry. The amount of waste precipitated in 1975 was about 12 million tons, and the 1990 forecasts mention a figure of 40 to 45 million tons. The major waste is fly ash from brown and hard coal and, to a lesser extent, a variety of slags.

Proposals are made concerning the maximum possible use of furnace waste for the production of such materials as: low- and medium-grade binding materials, building and special ceramics, cellular concretes, lightweight aggregates, cement, additives for concretes of various kinds, and diverse building units.

Utilization of Fly Ash for Production of Building Materials — Professor Dr. A. Paprocki.

The report details on the current state and possible use of fly ash for the production of building materials. Also discussed is the quality of domestic fly ash kinds, results of basic research conducted to date, and the criteria for the selection of a suitable fly ash grade for industrial application.

Some attention is paid to such subjects as possible use of this raw material for the production of binding materials, cellular concretes, building ceramics, light aggregates, trends of further research needed and specific proposals as to particular branches of the building materials industry.

Potential Use of Inactive Fly Ashes as a Binding Material in Road Building — J. Piotrowski, M.Sc. Eng.

The objective of the report was a brief analysis of the problem of the use of fly ashes (mainly inactive or of low activity ones) which are the majority of fly ashes produced by the domestic power plants.

The need for a different look at the question of activation and the use of fly ashes as a binding material in road building is pointed out. The use of fly ashes as a cement substitute in making concrete foundations, and as a component of fly ash-calcareous binding materials in the application for strengthening of foundation soils, seems to be the most effective from the engineering, economic and organizational standpoints.

The question of chemical activation was also analyzed with the conclusion that it is, for many reasons, a restraint in the effective and full utilization of this material. A suggestion is subsequently made to recover fly ashes for the uses mentioned, that investigation and experiments should be conducted on possible activation of the properties of the binding fly ashes as early as the coal combustion stage in the power plant furnaces. This suggestion is substantiated by some theoretical reasons and by results of the study related to the effect of addition of ground quartz on the change in chemical nature of fly ashes.

The Waste from Mining and Power Industries as a Raw Material for the Lightweight Aggregate Production — Docent Dr. J. Mojsiejenko.

On the basis of results of a study made and from the experience gained in the operating industrial plants, possible ways of utilization of waste produced by mining and power industries are discussed. The waste would be the fundamental source of this material for the developing lightweight aggregate industry in this country.

The following problems are highlighted in the reports:

- Use of raw and coal-deprived coal shales for the production of expanded shale aggregate;
- Utilization of fly ashes for the production of expanded fly-ash aggregate and Gralite;
- Use of the overlay clayey materials from the brown coal strip mines for the production of Keramzit and Glinoporyt (trade name for expanded clay aggregate).

Industrial Waste as a Source of Raw Materials for the Road and House Building Industry — J. Vargayi (Hungarian People's Republic).

As is generally recognized, the coal-fired plants generate in considerable amounts also fly ash, the waste of the combustion process. At the current use of power plants the quantity of this waste in ten major power plants in Hungary amounts to about 4 to 4.5 million tons annually. So far over 65 million tons of fly ash and slag were produced. It would be of advantage and highly desirable to establish as soon as possible some international cooperation in the field of reasonable use of this waste.

The Waste-Free Mining and Processing of Rocky Materials in the Environment Pollution Control Aspect — Dr. P. Żurawski, K. Krzemień, M.Sc. Eng.

Waste should be regarded as a resource of raw materials. Considering the environment pollution and economical use of natural resources the following principles should be observed:

- minimization of waste produced in the raw material mining and processing processes,
- improved production process employed,
- extended range of final products,
- creation of adequate conditions in the domain of organization, management and financing,
- observance of the principle of responsibility for the utilization of waste at the spot of its production,
- preference of production processes based on recycle materials over those based on natural resources.

Use of Marble Waste for the Marble Conglomerate Production — Dr. T. Strycharczyk.

The paper is concerned with the utilization of raw material and process wastes from gabbro mining and marble working for the manufacture of conglomerate and treats such subjects as: the significance of

marble products, the status in the marble waste utilization, and the block and conglomerate production.

The domestic experience with this material and the development of production of a variety of conglomerates abroad can serve as a basis for the industrial production of marble conglomerates in this country.

The Trends in Utilization of the Limestone Washing Slimes — H. Pilecka, M.Sc. Eng., M. Tomala, M.Sc.

The limestone slimes produced from limestone washing are a waste awkward in storing, as under natural conditions when disposed of in earthen settling ponds, they fail to dry up even over extended periods of many years. They occupy, therefore, unreclaimably the agricultural land, being additionally a threat to the environment.

From this slime, by means of a suitable hydro-classification, usable fractions of particle size above 0.1 mm can be isolated. On the other hand, the remainder material of particle size below 0.1 mm was demonstrated to be a valuable calcareous marly material, to replace limestone in a number of processes primarily in the building materials industry.

It was shown that the main trends in the washing slimes utilization include their concentrating in a closed cycle by sedimentation with flocculation with subsequent use in the cement manufacture by the wet method or for production of autoclaved gas concrete. The productions mentioned are of bulk type, capable of using up all the slime produced.

Evidence is also given for usefulness of the above material for the manufacture of mineral fertilizers, fertilizer flour, ceramic linings, limestone powder, for the production of asphaltic concrete, paint pigments, plasters and mortars, etc.

The economic and social advantages of the complete utilization of annoying and nondrying slimes are pointed out. The savings on a national scale are estimated at some 400 million zlotys annually. Additional benefits involve a complete elimination of settling ponds with the resultant improvement in conditions of the natural environment of man and reduced health hazard.

Peculiar Character of the Assumptions for the Deposit Recultivation in the Building Materials Mining Industry — Docent Dr. J. Dziewański, Z. Maśley, M.Sc. Eng.

Factors that affect the range and depth of the transformations caused by the operation of raw materials mining for the aggregate and building stone industry are discussed. Particular emphasis is placed on the elements

that should be considered in the first place in the appraisal of the assumptions for recultivation of the old development areas. These are:

- the kind of the mineral mined, the region of its occurrence and topography of the area,
- history of the rocks mined (differentiation of the mineral and chemical composition),
- extension of the raw material deposits and the method of its winning,
- the kind of transformation of land and its related disturbances in water management,
- land classification of the adjacent areas,
- potentiality of recovering the soils on the basis of the recultivation usefulness of soils covering the gotten areas.

A characteristic of these factors enables a preliminary classification to be made for the gotten areas of the building materials industry.

The final part of the report provides some observations that come from analysis of the factors which do or may affect the nature of changes in the areas or regions of minerals for the aggregate and building stone industry. This is particularly of significance for the following:

- designing of new mining plants,
- determining the trends to improve the currently existing state of the environment in the mining plants under analysis,
- elimination of the results of the mineral winning operations.

The Influence of the Building Materials Industry on the Environment in the Opole Region — Dr. K. Dubel.

The authoress suggests a number of preventive measures to reduce the progressing damage to the environment, such as:

- the strip mining developments should be concentrated on specific areas possibly on poor soils and the winning from retention reservoirs (Otmuchów, Nysa) should be enhanced, where deposits constitute a 34% of documented aggregate deposits in the Opole Voivodship;
- the winning forms should be integrated by decreased number of the winning units;
- recultivation work should be intensified to the extent that the annual land losses due to the winning would be made up by the area of reclaimed land;
- require from the plants annoying to the environment to develop protection zones and to enforce the development of these zones within a definite period and in a way that would guarantee the proper isolation of the protected areas.

**Forest Damage around the Limestone Industry Plants at GóraŹdŹe —
Z. Fuchs, Eng.**

An attempt was made at answering the question whether or not, within the framework of the usual procedure of setting up protection zones, there appear characteristic groups of injury of the assimilative apparatus of plants, and if there are any differences in the intensity of these injuries depending on the kind of industrial plant that affects vegetation of the zones.

To determine the degree of nuisance of the cement and limestone industry, the results collected in the test regions near the GóraŹdŹe plant were compared with the results obtained for analogous areas in the neighborhood of coke plant at ZdŹieszowice and the chemical and power plant at KŹdzierzyn.

Recultivation in the Building Ceramics Industry against the Background of the Kind of Deposits Mined and of the Winning Methods — Dr. J. SlobodŹiński, J. Wałecki, M.Sc. Eng.

The report contains a geological and qualitative characteristics of the raw materials base of the building ceramics industry and a mining and geological characteristics of the mines of raw materials of the building ceramics. The mines in question feature a fairly low depth of the bed being won and its considerable dispersion, with the resultant minor average output of the mine. This entails an extensive transformation of arable and forest land. Combined with considerable lag from the past years, this creates notable problems as concerns meeting the deadlines of recultivation and redevelopment of the area.

Specified in the report is the area of land under redevelopment, recultivated and planned for recultivation. The trends of the industry's activity are specified along with the conclusions as concerns limitation of the land transformed by deposit development and in the field of intensification of work related to recultivation and redevelopment of old mining land.

Selected Problems of the Natural Environment Conservation in the Area of Influence of the Refractories Industry — Dr. Z. Jakubczak.

The kinds of pollutants emitted from the refractories manufacturing plants are discussed with a treatment of the influence of these pollutants on the elements of natural environment, which are air, soil, and vegetation. Treated in detail are the adverse effects of influence of dusts, sulfur dioxide and especially of chromium compounds on individual crops.

In subsequent part of the report a critical estimation is made of the hitherto followed approach to the question of development of protection zones around industrial plants which is virtually confined to the afforestation of the area of the zone. A need was pointed out for a more reasonable use of protection zones for agricultural purposes, application of intense field management procedures, particularly on high grade soils to reconcile in a proper way the environment conservation and the agricultural production problems of high importance.

Noise Control and Acoustic Development of the Environment in the Building Materials Industry — Professor Dr. J. Sadowski.

The report deals with some general problems regarding the shaping of the acoustic climate of the working environment in the building materials industry and the noise control in that environment.

Information is given on the influence of noise and vibrations on the occupational disease incidence in the building materials industry plants.

The principles of the shaping of the acoustic climate and noise control are discussed along with the status of research in this field in Poland. The problems resulting from the annoying neighborhood, like the manufacturing plants — residential and other areas, are dealt with.

The report concludes with some observations on the guidelines for further research and for continued work connected with the noise control designing.

The Effect of Noise and Vibrations on the Building Industry Workers — J. Pastwa, M.D., M. Pałka, M.D.

The authors cover the noise and vibration sources in building industry. They cite results of measurements made in some building industry plants. Subsequently, upon discussing the kind of noise, they dwell at some length on the effect of noise on the human organism, in particular on the auditory organ. The extra-auditory noise effects, medical prevention, and especially periodical medical examination and proper selection of workers to be employed are treated in subsequent parts of the report. The sanitary guidelines for work organization under noise conditions conclude the article.

Principles for the Noise Protection Zones around Industrial Plants — Dr. M. Stawicka-Wałkowska.

The report is a synthesis of the principles of the setting up the protection zones around industrial plants that are nuisances as concerns

noise. With regard to the calculative method advanced the following subjects are covered:

- classification of industrial noise as a source of nuisance for the adjacent areas with consideration of the character of the noise level reduction as a function of distance;
- classification of industrial plants with respect to the noise level appearing at the noise source (i.e., inside production halls) or in case of field production at a distance of 10 m from the source;
- classification of noise levels outside of production halls, and the specific sonic insulation ability of the external hall structures used in Poland;
- a method for estimation of noise 10 m off the limit of the premises of an industrial plant (i.e., on the limiting lines) with an account of the effect of intermediate elements of the area development which act as a sonic screen for the major noise source;
- nomographs to evaluate the distance from the plant's limit, for which the sound level value due to the major noise source would correspond to the permissible sound level assumed;
- corrections to account for the character of the area development beyond the borders of an industrial plant;
- demarcation of the ultimate limit of the protection zone, which was the objective of the report.

Noise, Its Measurement Methods and Possibility of Its Abatement in Cement Plants — Kalman Szabo (Hungarian People's Republic).

In conformity with the requirements of the noise control regulations, the cement plants are obliged to take into account the present status of the knowledge in the domain of excessive noise prevention in designing and operation of machines and equipment. After a brief outline of the design stage solutions used to date, the author details individual noise kinds and the sites of their generation, and gives a characteristics of these noise kinds by the frequency analysis method.

The Noise Control Problems in the Cement Industry — J. Sajdak, M.Sc. Eng.

Results of investigation on the noise in cement industry are presented, which were gathered from the project referred to as the industry branch problem no. 116, and executed at the Institute of Building Bond Materials in Opole. Evaluation of the noise hazard included workplaces inside the plants and in the outside environment with particular emphasis on residential areas.

A method is advanced for the sound measurement on the premises of four selected cement plants and in their surroundings. The criteria are specified for noise evaluation used in the study, as well as the method of elaboration of the measurement data is presented.

Some attention is given to the degree of noise hazard to the environment caused by the plant, as well as noise hazard at particular workplaces in individual process units. As the following item the possibilities of noise abatement are treated by a variety of methods available.

The conclusions provide main guidelines for the work to be accomplished within the problem no. 116 mentioned and the tasks resulting therefrom for the Institute.

The Noise Protection in the Precast Concrete Units Plant — Dr. B. Szudrowicz.

The report is elaborated on the basis of results of the research project on noise abatement by sound-proofing and building techniques in the precast concrete units plants, conducted under the industry branch problem no. 116 at the Institute for Building Technics.

Covered in the report are major noise sources together with their detailed acoustic characteristics.

Considering the kind and character of the noise exposure of the crew at individual workplaces, the question of permissible noise level for precast concrete plants has been analyzed, and the rationale of the interpretation of the requirements provided in the standard PN-70/B-02151 is given.

In the part concerned with the noise control in the plants possibility of a reduction of the noise hazard of the crew has been discussed in terms of a suitable sonic adaptation of the hall, which would consist in a dividing of the hall along the line running through the column line with sound-absorbing screen walls to suppress the noise in the hall room. The hall division enables to isolate major noise sources, thus to reduce considerably the noise exposure time of the crew.

Possible sound absorption engineering measures were also discussed, which would be fitted on the noise source itself (vibration sites) by means of adequate foundations and by the use of sound-absorbing housings.

Possibilities for Noise Suppression in the Quarries and Stonework Plants — Kertesz Laszlo (Hungarian People's Republic).

The report contains:

— a brief summary of the regulations related to the industrial acoustic conditions;

- a brief description of operation of a stonework industry plant and the current conditions for the noise there;
- application of the noise sources in quarries and stone working plants and in the artificial stone manufacturing plants, and the methods used there for noise abatement;
- a listing of noise levels and classification of noise sources;
- audiometric examination of the quarry workers and machine operators exposed to noise hazard; measurement methods;
- conclusion and analysis of results of the examination in terms of the age and employment period of the workers.

The Noise Control Principles in the Joinery Industry — J. Sułocki, M.Sc. Eng.

The joinery plant manufactures wooden goods by machining followed by manual assembling. The operations are the source of emission of considerable acoustic power over a wide frequency range and material vibration. Noise and vibrations are essential hazard for the crews in that industry, and necessitate extensive preventive activity by adequate noise control.

Organizational principles of the noise control are given along with the guidelines for the measures to combat noise by active and passive means.

Attention is paid to the requisite preventive measures in the conceptual phase of designing of the new and modernizing of the existing plants.

The shortages in materials, structural elements, and other means to control noise and vibrations in this country have been pointed out on the example of the joinery industry.

Owing to an ample participation in this conference of the representatives from all the companies and agencies concerned, to the opportunity of exchanging experience with the brotherly socialist countries, as well as owing to a comprehensive treatment of the environment pollution control problems in the course of the conference and in the final resolution adopted, it should be expected that the international conference in point may contribute to a due estimation of the importance of the problem discussed and to a proper guidance in undertaking planned and systematic activities to eliminate potential adverse effects of the ever-growing development of the building materials industry.

Prepared by H. Gołajewska

ANNOUNCEMENTS

Reduction of the Fluorine Compounds and Chlorine Compounds Emission into the Atmosphere

The PROAT Atmosphere Conservation Designing Office is the sponsor of the First COMECON Symposium on Reduction of the Fluorine Compounds and Chlorine Compounds Emission into the Atmosphere, to be held on October 5-9, 1977 in Szczecin.

The Symposium is related to the work performed under research subject no. IV-16 of the general extensive COMECON and Yugoslavia cooperation program in the domain of environment pollution control and engineering. Within the subject mentioned the PROAT Office serves as the domestic coordinator of the cooperation.

The subject matter of the Symposium includes:

- problems of the fluorine compounds emission,
- equipment and processes for the fluorine compounds removal from the off gases,
- fluorine recovery processes from spent liquors,
- structural material used in construction of the apparatus,
- fluorine compounds determination techniques for the off gases and for the atmospheric air.

Participation application, accompanied by copies of the reports in the Polish and Russian (two copies each) should be mailed by the end of July 1977 to the following address: Biuro Projektów Ochrony Atmosfery PROAT, 70-562 Szczecin, Pl. Orla Białego 1.

J.M.

The Second Conference on the Waste Gas Cleaning

Institute of Environment Pollution Control Engineering, Technical University of Wroclaw is sponsoring the second conference on the Waste Gas Cleaning to be held on September 23-25, 1977. The problems will encompass the questions of the particulate and gaseous pollution control. A vast number of reports and communications from this field will be presented at the conference.

J.K.

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